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THE CANADIAN JOURNAL.

NEW SERIES.

No. XLIX.—JANUARY, 1864.

A POPULAR EXPOSITION OF THE MINERALS AND GEOLOGY OF CANADA.

BY E. J. CHAPMAN, Ph. D.
PROFESSOR OF MINERALOGY AND GEOLOGY IN UNIVERSITY COLLEGE, TORONTO.

(Concluded from Vol. VIII. page 462.)

GENERAL OUTLINE AND RECAPITULATORY SKETCH OF THE GEOLOGY OF CANADA.

1. *Canadian Rock Formations.*—The rock groups occurring within the limits of Canada, comprise representatives of the Azoic, Lower Palæozoic, and Post-Tertiary series. The Upper Palæozoic deposits (inclusive of the Coal Measures proper) together with the entire formations of the Mesozoic and Cainozoic Ages, are altogether unknown within the limits of the Province.

2. *Azoic Series.*—The rocks of this series, composed of Sedimentary matters deposited in ancient seas, apparently before the creation of organic types, and subsequently rendered more or less crystalline by metamorphic forces, are subdivided into two formations. The lower of these is named the Laurentian, and the higher, the Huronian Formation. The Laurentian strata consist principally of highly crystalline beds of micaceous and hornblendic gneiss; hornblende rock; crystalline limestone and dolomite; oxidized iron ores; quartzite; and anorthosites, or rocks composed chiefly of lime and soda feldspar. In

an economic point of view, the Laurentian Formation is essentially characterised by the vast beds of magnetic and specular iron ore that occur within it: full details of which are given in a preceding page. The formation is many thousands of feet in thickness, and it covers an area of 200,000 square miles—running from Labrador along the north shore of the St. Lawrence to the vicinity of Quebec, and throughout all the more northern and north-western portions of the Province, as shewn in the sketch-maps, figs. 154 and 243. By reference to the latter, it will be seen that in the district between Prescott and Kingston, a narrow belt of this formation crosses the St. Lawrence, and expands over a large extent of country, comprising the Adirondack region, in the State of New York. This belt forms a somewhat important featnre in the geology of Western Canada. It will be alluded to again, in connection with this sketch, under the name of the "gneissoid belt of the Upper St. Lawrence." The Huronian Formation which constitutes the higher division of the Azoic series, consists chiefly of green and greyish slate-conglomerates and other partially altered strata, interstratified with greenstone masses, and traversed by numerous trap dykes. It contains also many quartz veins, holding copper pyrites and other copper ores in workable quantities. The total thickness of the formation is probably not much under 20,000 feet. Its strata are chiefly developed along the north shore of Lake Huron (No, 2, in fig. 243), and in places on Lake Superior.

3. *Laurentide Mountains. North and South Basins of Canada.*—A high water-shed or range of mountainous country, averaging a height of from one to two thousand feet above the sea, but rising in places to nearly four thousand feet, traverses the greater portion of the Laurentian area, and forms at one part of its course the "Laurentide Mountains." It divides the Province into two great basins or geological areas: known, respectively, as the North and South Basins.

4. *Great Northern Basin of Canada.*—The area occupied by this basin, lying to the north of the Laurentian water-shed, and sloping towards Hudson's Bay, as regards its geological characters, is still comparatively unexplored. The formations known to occur within its limits, comprise the Laurentian and the Upper Silurian series. The Huronian rocks are thought to occur also, in the form of Chloritic schists, in the valley of Lake Temiscaming, but no traces of Lower Silurian strata have anywhere been met with. Hence, it is suggested by Sir William Logan, that, the Laurentide mountainous

range formed, from Labrador to the Arctic Sea, the northern shore line of the ocean during the Lower Silurian period. The land to the north, being thus above the level of the sea, would receive no deposition of Lower Silurian strata; but an after movement of depression must have ensued during the Upper Silurian epoch, bringing down this northern district beneath the sea, and so enabling the sediments of the latter period to be laid down upon its area.

5. *Great Southern Basin of Canada: Its subdivisions:*—The southern geological area of Canada, is in itself divisible into three smaller basins: (1) the Basin of the lakes; (2) The Basin of the St. Lawrence; and (3) The Eastern or Metamorphic Basin. The two first of these are separated from each other by the gneissoid belt of the Upper St. Lawrence alluded to above; whilst the third or Eastern Basin is separated from the St. Lawrence area by a remarkable dislocation, accompanied by physical and chemical changes of great moment. This dislocation is evidently connected with the elevation of the Appalachian mountain chain. As traced in Canada by Sir Wm. Logan, it runs from near the northern extremity of Lake Champlain in a general north-easterly direction to the St. Lawrence, which it crosses immediately above Quebec; and then turns to the east, traversing the northern part of the Island of Orleans and passing down the river into the Gulf, from whence it appears to re-enter the south shore a few miles above the mouth of the Magdalen River in Gaspé. The strata within the area circumscribed by this dislocation, are thrown up generally into highly inclined beds; and they exhibit, in other respects, many signs of the action of powerful disturbing forces. See under the head of the "Calciferous Formation," on a preceding page. In the more central portion of the area, also, they are much altered, or converted into crystalline schists, &c., and rendered metalliferous by metamorphic agencies. The strata of the Lake and St. Lawrence Basins, on the other hand, betray few signs of these disturbing influences, except in the case of the upper copper-bearing series of Lake Superior, and in parts of Gaspé, as described fully in a preceding division of this Essay.

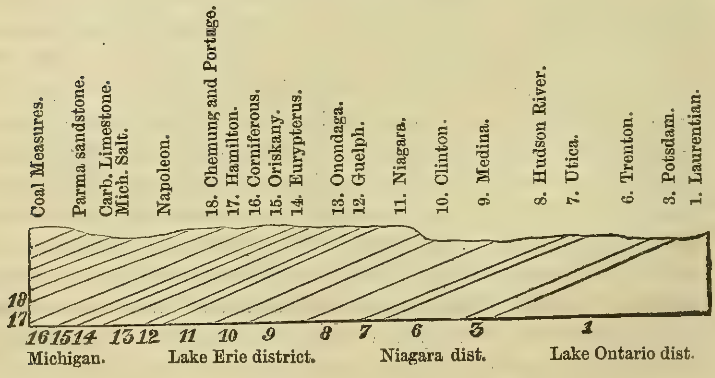
6. *The Lake Basin of Canada:*—Of this geological basin, properly speaking, only the north-eastern and northern portions actually occur within the boundaries of the Province. It includes all the area to the east or left of the Laurentian district marked 1—1 in the sketch-map fig. 243. Though affected here and there by slight local disturbances,

the strata within this area have a *general* westerly dip, extending as far as the central part of Michigan, in consequence of which, on proceeding from the gneissoid belt of the Upper St. Lawrence, just east of Kingston, towards the southern extremity of Lake Huron, the various formations (exclusive of the Calciferous and Chazy series?) from the Potsdam to the Hamilton beds, with those also of Kettle Point, are successively traversed. The dip of these strata, however, (except here and there, under local conditions) is exceedingly slight, rarely exceeding two or three degrees, and averaging in general less than half-a-degree, or about 30 or 40 feet in a mile. The annexed section will serve to convey a general idea of the sequence of these formations, as shewn on the map, between the gneissoid belt east of Kingston, and the coal strata of central Michigan. The thickness of intervening rock between the top of the Hamilton formation and the lowest of the Michigan coal seams, is about 840 or 850 feet.

Fig. 250.

SKETCH–SECTION OF FORMATIONS OF WESTERN PART OF CANADA AND EASTERN MICHIGAN.

(The dip necessarily exaggerated.)



At the extreme east of this basin, a little beyond Kingston, a narrow band of Potsdam sandstone rests on the western slope of the gneissoid or Laurentian rocks. This is followed to the west—the Calciferous and Chazy formations being apparently absent—by the strata of the Ontario group, comprising the Birds-eye, Black River, and higher limestones of the Trenton formation, the dark bituminous Utica schists, and the arenaceous shales, &c., of the Hudson River Series. The

Trenton formation is probably abont 700 or 750 feet in thickness; the Utica shales, somewhat under 100 feet; and the Hudson River series, between 700 and 800 feet. These formations are developed chiefly along the shore of Lake Ontario, between Kingston and the central part of Nelson township, west of Toronto; and also on the shore of Georgian Bay, between Cape Crocker and a spot a little south of the outlet of the River Severn; as well as throughout all the intervening country: including within the Trenton area, Lake Simcoe, Balsam Lake, Rice Lake, and other bodies of water. Kingston, Belleville, Peterborough, Cobourg, Port Hope, Barrie and Collingwood, are situated over the Trenton district; Whitby and the country just west of Collingwood harbour, over the Utica formation; and Toronto, Oakville, Sydenham (Owen Sound,) and Meaford, over the Hudson River strata. These various formations, as explained fully under their respective descriptions on a former page, run also across the northern part of the Manitoulin Islands.

The Niagara or Anticosti group succeeds the Lower Silurian strata. The Medina Formation (Map: No. 9), at its base, sweeps round by Queenston, Hamilton, &c., below the great escarpment of that district, and continuing its course, first towards the north and then towards the north-west, comes out upon Georgian Bay near Cabot's Head, forms the extreme base of that promontory, and runs, it is supposed, in a narrow belt along the central part of the Manitoulin Isles. These Medina strata consist chiefly of red marls, shales, and sandstones, capped by a grey freestone, known as the "grey band." On Lake Ontario, they exceed 600 feet in thickness, but diminish considerably towards their north-western limits. The green and red shales of the Clinton division (No. 10,) with their interstratified limestone beds, appear above the grey band of the Medina formation proper; and are succeeded by the calcareous shales and limestones of the Niagara formation, holding *Pentamerus oblongus*, fig. 213, amongst their other fossils. The Niagara limestone (Map: No. 11) appears to represent in the Middle Silurian strata, the great Trenton limestone of the Lower series. Still higher in the scale, and farther to the west, follow successively the Guelph dolomites (No. 12), the gypsiferous and fossil-free strata of the Onondaga formation (No. 13), and the slightly developed Eurypterus beds of the Lower Helderberg group. These close the Silurian series, The country between the upper part of the Niagara River and the north-eastern shores of Lake Huron, is occu-

pied by these Middle and Upper Silurian formations, but their strata are mostly concealed by Drift-deposits. The localities in which instructive exposures occur, have been mentioned under the separate descriptions of each formation, at the commencement of this Part of our Essay. The Clinton beds near the mouth of the Niagara River are only a few feet in thickness, but they increase towards the north-west, and attain, on the shores of Georgian Bay, a thickness of about 180 feet. The Niagara formation increases in the same direction, from about 240 or 250 feet, to probably about 400 feet. The Guelph formation at its thickest part is estimated by Sir Wm. Logan at 160 feet. The Onondaga formation averages from 200 to 300 feet.

Still further to the west, a thin band of sandstone, belonging to the Oriskany Formation (Map : No. 15), crops out above the Eurypterus beds in the townships of Bertie, Cayuga, &c. This forms the base of the Devonian series. It is succeeded by a large development of the cherty limestones of the Corniferous Formation, (No. 16), averaging collectively about 200 (?) feet in thickness, and supposed to be the source of the Petroleum supplies of that district. These are followed by the encrinal limestone bands and calcareous shales of the Hamilton (or Lambton) series (No. 17,) making up an additional thickness of from 200 to 300 feet. Finally, at Kettle Point, and in the townships of Warwick and Brooke, a few isolated patches of dark bituminous shales, containing calamites and fish-scales, conclude the Devonian series as developed in this part of Canada. These bituminous shales, are referred to the base of the Portage group (No. 18). The relations of the Hamilton or Lambton shales to the underlying Corniferous strata, and the chief points of interest belonging to the occurrence of petroleum in this region, have already been sufficiently discussed.

The Drift accumulations spread so generally over this western basin, consist of thick beds of clay, overlaid in most places by deposits of sand and gravel, with boulders of gneiss, syenite, limestone, and other rocks. The thickness of the entire mass varies greatly, but in places it exceeds 100 feet. In the upper Drift beds, or rather in those formed out of Drift and other materials by Post-glacial influences, numerous shells of existing fresh-water mollusks (*planorbis*, *cyclas*, &c.), occur at different heights above our present lake-waters ; whilst there seems to be an entire absence, in these beds, of marine or estuary types, such as occur in deposits of a similar age in the St. Lawrence basin. Hence the inference, that, at a comparatively recent geological period, our

great lakes were united into one vast fresh-water sea, held back, on the east, by an elevation of the gneissoid belt of the Upper St. Lawrence or perhaps by a huge glacier-barrier extending in that direction, as explained on a former page.

7. *The St. Lawrence Basin:*—This Basin is separated from the Basin of the Lakes, just described, by the gneissoid band, which, passing southwards from the Lac des Chats on the Ottawa, crosses the St. Lawrence at the Thousand Isles, and forms the Adirondack region of New York. On the other hand, it is cut off from the Eastern or Metamorphic Basin (although, strictly considered, this forms an isolated central portion of its area) by the great dislocation alluded to under §5, above. This dislocation, accompanied both by a great upheaval and the manifestation of active metamorphic forces, runs from near the northern extremity of Lake Champlain to Quebec, and from thence along the north shore of the Island of Orleans, and down the river and gulf, as far as the coast of Gaspé, which it enters near the mouth of the Magdalen River. The area of the St. Lawrence Basin thus includes the peninsula between the gneissoid belt, the lower Ottawa, and the Upper St. Lawrence, together with a large extent of the south shore of the latter river, and all the north shore from the Ottawa to the Gulf, except a small portion (including the chief part of Quebec) lying within the above mentioned line of dislocation. It may be considered to include, also, the extreme eastern and southern parts of Gaspé; the Island of Anticosti, and the Mingan Islands. Towards the western part of this area, more especially in the peninsula just west of the junction of the Ottawa and St. Lawrence Rivers, the Potsdam and Calciferous formations (Map: Nos. 3 and 4) are well displayed, together with the Chazy and Trenton limestone beds (Nos. 5 and 6). The latter occur also largely on the eastern side of the Ottawa, as around Montreal, &c.; whilst the Utica and Hudson River formations extend more particularly along each bank of the St. Lawrence up to (and on the north, beyond) Quebec—apart from the small area, immediately around Quebec itself, cut off by the before-mentioned dislocation. At the Falls of Montmorenci, the Trenton, Utica, and Hudson River divisions occur in force; and the latter runs along the north side of the Island of Orleans. These formations occur also in the small outlying basin of Lake St. John on the Upper Saguenay. The Trenton limestones form likewise some isolated patches on the north shore of the Gulf, as at the Seven Islands, the Straits of Belle Isle, &c.; whilst the

Mingan Islands consist chiefly of the Chazy formation, the Trenton beds appearing at the south side of Large Island, one of the group. The northern shore of the Island of Anticosti is made up of Hudson River beds, the rest of the island consisting of Middle Silurian strata. In Gaspé, the Hudson River formation occurs on the north shore, between Cape Rosier and the River Marsouin. Eastward and southward the peninsula is chiefly composed of strata referred to the Devonian series, in which a thin seam of coal and numerous fossil plants are met with; whilst along the Bay of Chaleurs and the coast south of Gaspé Bay, the inclined Devonian beds are overlaid unconformably by a vast thickness (amounting to no less than 300 feet) of Carboniferous sandstones and conglomerates, the *Bonaventure Formation* of Sir William Logan. These strata, however, are quite destitute of coal.

Monntainous masses of eruptive traps and trachytes occur towards the more western extremity of the St. Lawrence Basin. These break through Lower Silurian strata, and were formed, probably, during the Upper Silurian or earlier part of the Devonian epoch. They are traversed in most cases by dykes of more recent origin—apparently erupted towards the close of the Devonian period, or perhaps at a still later date. The more important of these intrusive masses, comprise: Rigaud (in Vaudreuil Co.); Mount Royal or the Montreal mountain; Montarville or Boucherville (in Chambly Co.); Rougemont (in Rouville Co.); Belœil (in Verchères Co., near the Grand Trunk Railway); Monnoir or Mt. Johnson, south of Belœil; and Yamaska. Other masses of a similar character, as those of Brome and Shefford, lie just within the Eastern or Metamorphic Basin; but as these are evidently connected with the above series, the whole may be described together. The mountains of Montreal, Montarville, and Rougemont, are essentially augitic traps or dolerites. They present a dark color in most parts, and contain, in many places, distinct and comparatively large crystals of augite; Fig. 251. Small granular masses of olivine, with black grains of Magnetic Iron Ore and Ilmenite (minerals described in PART II.) are also commonly present, especially in the Montarville and Rougemont mountains. These trappean masses are penetrated by dykes of white or light-coloured compact trachyte (see PART III.), which contain minute crystals of iron pyrites, and generally effervesce in acids from the presence of intermixed carbonate of lime. The Rougemont mountain, is traversed also by granitic trachyte

Fig. 251.

(PART III.) of a grayish colour, and partly micaceous. The mountains of Rigaud, Belœil, Monnoir, Yamaska, Shefford, and Brome, are essentially granitic trachytes, consisting of light-coloured potash-feldspar, with small grains of black hornblende, or scales of brown or black mica; and usually containing, in addition, some small crystals of yellow sphene (see PART II.) and grains of magnetic iron ore. Much valuable information on the composition of these picturesque and interesting mountains, is given by Professor Sterry Hunt, in the Geological Report for 1859. See also the *Canadian Journal*, Vol. V., p. 426, and the *Revised Report of the Geological Survey*, 1863.

The surface of the St. Lawrence Basin, like that of the Lake area, is also very generally covered by thick accumulations of the Drift and Post-glacial epochs: comprising clays, gravels, and boulders. But the fossil shells, found in the upper part of these, are all of a marine or estuary character. They are referrible to species which still exist in the Gulf of the St. Lawrence, or on the coast of Labrador. These shells occur, not only on comparatively low levels, but at considerable heights also, above the present surface of the sea. Some of the most noted localities comprise the neighbourhoods of Ottawa and Montreal; terraces on the Montreal Mountain: one, nearly 500 feet above the sea-level; Beauport near Quebec, about 120 feet above the sea; and various terraces on the Lower St. Lawrence, the Ste. Anne River, the Matanne, the Metis, &c., in the Gaspé peninsula, at heights varying from 40 or 50, to 245 feet above the present sea-level. It is evident, therefore, that at the commencement of the Post-glacial or present period, the entire or greater part of the St. Lawrence basin must have been deeply submerged beneath the sea.

8. *The Eastern or Metamorphic Basin of Canada*:—This basin, forming strictly, a portion of the St. Lawrence area, is separated from the latter by the great dislocation already described in §§ 5 and 7. It includes the site immediately under and around Quebec, the central and southern part of the Island of Orleans, the south shore of the St. Lawrence from a little west of Point Levis to near the Magdalen River, and all the intervening area to the south (including the greater part of the eastern townships, &c.) as far as the Province boundary. In the more northern part of this region, the strata, consisting of the Calciferous and Chazy formations (united into the Quebec group), are raised along the line of the before-mentioned dislocation into a position apparently above the horizon of the Trenton series. (See the remarks,

on this point, under the head of the Calciferous Formation, towards the commencement of the present Part of our Essay). They are also highly inclined, and consist chiefly of black and other coloured graptolitic shales, with associated beds of dolomite, limestone, &c. At a certain distance south of the St. Lawrence, and more especially in the counties of Bagot, Drummond, Shefford, Orford, Brome, Stanstead, Sherbrooke, Megantic, Beauce, &c., these beds are much altered by metamorphic action: being changed into gneiss-rocks, talcose and chloritic schists, serpentines, variously coloured marbles, and other rocks of a similar metamorphic character; whilst their fossils become gradually obliterated. They are associated also in many of these localities, with vast irregular masses of copper and iron ores; and are traversed by veins containing galena, and here and there by auriferous quartz-veins. These metallic deposits, with the marbles, slates, and other economic substances of the region, are enumerated more fully under the Calciferous Formation, on a former page. The alluvial matters derived from the disintegration of the metamorphic rocks of this Eastern Basin, contain grains and occasionally small nodules of native gold—as explained at the same place, and also under the description of that metal in Part II. The Notre Dame and Shickshock Mountains, an extension of the Alleghanian chain, belong to the north-eastern part of this area. These mountains, which rise in places to a height of 4,000 feet above the sea, consist of metamorphic strata of the Quebec group, including vast beds of serpentine and intermixed chromic iron ore. The eruptive granites of the Megantic Mountains, and those which occur in Winslow, Hereford, Stanstead, Barton, Weedon, and other neighbouring townships, lie also within the limits of this metamorphic zone.

ON THE ANNUAL AND DIURNAL DISTRIBUTION OF THE DIFFERENT WINDS AT TORONTO.

BY G. T. KINGSTON, M.A.

DIRECTOR OF THE PROVINCIAL MAGNETIC OBSERVATORY, TORONTO.

The accompanying tables were derived from hourly records of the wind with Robinson's anemometer in the years 1853 to 1859 inclusive, during which period, with very few and short interruptions, the instrument was in continuous operation.

The monthly and hourly resultant directions and velocities include only the years 1854 to 1859, and were computed from the well known formulæ

$$\tan.\ \bar{\theta} = \frac{\Sigma(v \sin\theta)}{\Sigma(v \cos\theta)}; \qquad \bar{r} = \frac{\Sigma(v \cos\theta)}{n \cos\bar{\theta}}.$$

RESULTANT DIRECTIONS IN THE DIFFERENT MONTHS.

A comparison of the monthly resultant directions given in table I. shews that the general direction of the atmospheric current is considerably more from the westward in the winter than in the summer months, the monthly resultants oscillating about N. 43° W. from April to September inclusive, and about N. 72° W. during the remaining six months.

There is a much nearer approach to uniformity of direction in the different years for some months than for others; for instance, taking the angular difference between a monthly partial resultant in a particular year and the corresponding monthly resultant for the six years as a rough measure of the irregularity of the partial resultant, it is found that the averages of these differences are 7° for January and about 75° for June and July. The quarterly averages of the differences are for winter (commencing December 1st), 20°; for summer, 53°; for spring, 29°; and for autumn, 27°: their half-yearly averages being 46° from April to September inclusive, and 19° from October to March.

RESULTANT VELOCITIES AND MEAN VELOCITIES IN THE DIFFERENT MONTHS.

The resultant velocities and mean velocities have each their maximum in March and their minimum in July. The change from month to month is regular in both, with the exception of a small interruption of continuity in August, and another in December.

RESULTANT DIRECTIONS OF THE WIND IN THE DIFFERENT HOURS.

Confining our attention in the first instance to the annual resultants given in table II., we find that during the hour commencing noon the resultant wind is from N. 103° W., its extreme distance on the left of north. From this point, at which the wind is nearly steady during the three hours commencing at noon, it draws round regularly and continuously till it makes its nearest approach to the north (N. 38° W.) at 5 A.M., about which point it remains nearly steady from midnight to 7 A.M. It then rapidly recedes again to the westward.

The extreme recession of the resultant direction from the north takes place during the first three hours after noon in all months excepting in November, when it occurs between 11 A.M. and noon, and in December, when it is between 3 P.M. and 5 P.M. It occurs in May between 1 P.M. and 2 P.M., but in a contrary direction to that of all other months, being 108° to the *east* of north.

The hours of nearest approach to the north are not so well marked and are included within wider limits. For most months they were found between midnight and sunrise, but in May, June and November they occur in the early part of the night. The angular diurnal range in the direction of the resultant is 180° in July (its maximum) and 15° in November (its minimum). The quarterly averages of the diurnal ranges are 25° from December to February, 85° from March to May, 152° from June to August, and 65° from September to November; also the half yearly averages are 135° from April to September, and 29° from October to March.

MEAN RESULTANT VELOCITIES OF THE WIND IN THE DIFFERENT HOURS.

By table III. it is seen that the maximum resultant velocity for the whole year occurs during the hour commencing 1 P.M., and the minimum during the two hours between 4 A.M. and 6 A.M., the progression being continuous from the maximum to the minimum and to the maximum again, if the second place of decimals be disregarded.

The maximum takes place in one of the three hours commencing noon in every month but April and May, when it is found in the hours commencing at 9 P.M. in April and at 7 A.M. in May. The hours of minimum are not well marked in the separate months, and in July, August and September there is a double progression.

MEAN VELOCITIES OF THE WIND IN THE DIFFERENT HOURS.

On the average of the year, as shewn in table IV., the maximum velocity is from 1 P.M. to 2 P.M., and the minimum from 1 A.M. to 2 A.M. The maximum occurs in every month during one of the four hours commencing noon, and the minimum in most months within three hours of midnight, a prominent exception being in December, when the minimum is at 7 A.M.

MEAN VELOCITIES OF THE WIND IN DIFFERENT DIRCTIONS.

From table V. which includes only the winds at the six observation hours, we learn that the wind has a maximum mean velocity of 10.90 miles per hour when it blows from N.W., and a minimum mean velocity of 5.22 miles when it blows from S.E. There is an interruption to the continuity of the progression amounting to a second maximum at about E.N.E. and a second minimum at about N.N.E.

ANNUAL DISTRIBUTION OF THE DIFFERENT WINDS WITH RESPECT TO DURATION.

The results given in tables I. to IV. depend on the *velocities* as well as on the *durations* of the different winds; and as the average velocities in some directions are much greater than in others, these tables convey but indirect information as to the comparative prevalence of the different winds with respect to their duration. To supply this want tables VI. to IX. are given which were computed in the following manner.

From the monthly abstracts which give the direction of the wind during every hour of every day, tables for each month in the seven years 1853 to 1859 were formed, containing the number of times during like hours that the wind blew from each of the sixteen principal points, as well as the number of absolute calms in each group of like hours. By combining these tables the two following auxiliary tables were prepared.

Table (A) giving the absolute durations in hours of the different winds and of the calms for the several months, each month embracing the observations of seven years.

Table (B). The absolute durations of the different winds and of the calms for each of the twenty-four hours, each hour including all the winds recorded for that hour in the seven years.

Table VI. is derived from table (A) by expressing the absolute duration of each wind in each month and in the year, in terms of the monthly and annual mean durations for all winds. It is designed to give, for each month separately, and for the year collectively, a comparative view of the duration of the different winds.

It appears that winds from between S.S.W. and north have a more than average duration as compared with other winds taking the year round; but it is only those from N.N.W. whose duration exceeds

the average in each separate month. Winds from E.N.E. and E. are above the average on the whole year as well as in each separate month but December, January, February, and August.

The north wind is above the average of all winds on the whole year, and is above the average in some months and below it in others, but without any perceptible annual period.

The duration of the south wind is below the average of all winds, taking the whole year collectively, as well as in each separate month but May, June, July and August.

The wind of maximum duration for the whole year collectively is N.N.W. and the wind of minimum duration S.E. with a second maximum at east and a second minimum at N.N.E.

The principal maximum is found at some point between W.S.W. and N.N.W. in seven months; but in April, May and June east winds are the most frequent, and in July and September the most frequent wind is from S.S.W.

The wind of least duration is from S.E., S.S.E. or south in seven months; but in May, July, August, and September,* the least frequent wind is from W.S.W., and in June it is from N.N.E.

In table VII. the durations of the same wind in the different months are compared. As the months are of different lengths, instead of comparing the absolute durations, which for the longer months would be unduly great, this table is obtained by expressing the numbers of table VI. in terms of the annual arithmetic means for the several winds.

The change in duration from month to month exhibited by this table is very irregular, excepting in the case of the south wind, which decreases in duration continuously from its maximum in June to its minimum in December, the maximum being to the minimum nearly in the ratio of 8 to 1.

If N_3 be taken to denote the ratio which the duration of winds from the three points N.N.W., north and N.N.E. in the six winter months (October to March) bears to the duration of the winds from the same three points in the summer half year, and if N_7 be the corresponding ratio when the winds from north are associated with those from the three points on either side of it from W.N.W. to E.N.E., the ratios for the analogous combinations about the three other cardinal points being represented by S_3, S_7, E_3, E_7, W_3, W_7; it is found that

* In September, the duration of the wind from E.S.E. is the same as that from W.S.W.

$N_s = 0.91$; $S_s = 0.49$; $E_s = 0.65$; $W_s = 2.24$;
$N_7 = 1.01$; $S_7 = 0.91$; $E_7 = 0.70$; $W_7 = 1.39$;

Again, if the durations of the winds in the northern and in the western groups be compared with those of the groups diametrically opposite, and $\left(\frac{N}{S}\right)_s$ be employed to denote the ratio whose first term is the duration of the winds from the three points about north, the ratios between the other groups being expressed in an analogous manner, we have

	$\left(\frac{N}{S}\right)_s$	$\left(\frac{N}{S}\right)_7$	$\left(\frac{W}{E}\right)_s$	$\left(\frac{W}{E}\right)_7$
Winter	= 1.94;	= 1.36;	= 2.18;	= 2.25;
Summer	= 1.04;	= 1.22;	= 0.63;	= 1.13;
Year	= 1.34;	= 1.30;	= 1.25;	= 1.59;

DIURNAL DISTRIBUTION OF THE DIFFERENT WINDS WITH RESPECT TO DURATION.

The comparative durations, for each hour, of the sixteen winds and the calms are obtained by dividing the absolute duration of each wind in the hour by the average duration of all winds, including calms, in the same hour. The results are given in table VIII.

From this table the following facts may be gathered:

I. The durations of the winds from W.S.W. to N.N.W. inclusive, for each hour separately, as well as for all hours collectively, are above the average duration of all winds.

II. The durations of winds from E. to E.N.E., taking the twenty-four hours collectively, are above the average; and excepting from 2 A.M. to 3 A.M., one or other or both of these winds are above the average at all hours.

III. The durations of the north winds are above the average for the whole day collectively, and have a marked diurnal period, their durations being above the average duration of all winds from 9 P.M. to 9 A.M., and below the average from 9 P.M. to 9 A.M.

IV. The south winds have a duration less than the average of all winds, taking one hour with another, and they also have a diurnal period, their durations being above the average duration of all winds from 10 A.M. to 6 P.M., and below the average during the rest of the twenty-four hours.

V. The principal maximum occurs with the wind from S.S.W. from 11 A.M. to 4 P.M., namely, during a portion of the time when the duration of the south wind is above the average, and it occurs with the N.N.W. and north winds mostly at the hours when the duration of the north wind is above the average, a second maximum vibrating from east to E.N.E. during the whole of the day and night. From 9 A.M. to 11 A.M., and from 4 P.M. to 7 P.M., namely, when the north and the south winds respectively are near their averages as compared with other winds, and when the winds in the N.W. quadrant are more equally distributed among its several points, the easterly or second maximum surpasses in value the westerly or principal maximum.

The character of the diurnal periodicity of the different winds is more apparent in table IX., in which the duration of each wind at each hour is expressed in terms of the average duration of that wind in the twenty-four hours.

If the columns corresponding to the four cardinal points be examined, it is found that the west wind, during the night, is mostly above the twenty-four-hour average, and below that average during several hours of the day; but the range is small, the maximum being to the minimum in the ratio of 1.36 to 1.

The east wind from 8 A.M. to 9 P.M. is above the twenty-four-hour average for that wind, and is below the average from 9 P.M. to 8 A.M., its diurnal range, or the ratio of the maximum to the minimum, being 2.40 to 1. The north wind is above the average from 10 P.M. to 9 A.M., and below the average from 9 A.M. to 10 P.M., and has a range of 3.44 to 1. The south wind is above the average from 10 A.M. to 7 P.M., and below it from 7 P.M. to 10 A.M. Its range is 4.82 to 1.

Calms occur eight times as often between midnight and 1 A.M. as they do between 1 P.M. and 2 P.M. The hours of maximum and minimum frequency of calms are very nearly the same as those of minimum and maximum mean velocity, a correspondence which, as appears from table VII., does not hold in the case of the *annual* distribution of calms.

TABLE I.

Resultant Direction, Resultant Velocity, and Mean Velocity of the Wind, for each Month.

RESULTANT DIRECTION.

	January.	February	March.	April.	May.	June.	July.	August.	September	October.	November.	December.	Year.
1854	N 77° W	N 7° E	N 53° W	N 50° E	N 90° E	N 24° E	N 131° W	N 64° W	N 22° W	N 45° W	N 90° W	N 44° W	N 45° W
1855	N 73 W	N 40 W	N 88 W	N 36 W	N 1 W	N 69 W	N 161 W	N 63 W	N 20 E	N 82 W	N 66 W	N 92 W	N 64 W
1856	N 75 W	N 81 W	N 71 W	N 29 E	N 4 E	N 159 W	N 79 W	N 50 W	N 101 W	N 76 W	N 95 W	N 93 W	N 71 W
1857	N 70 W	N 102 W	N 63 W	N 60 W	N 23 W	N 49 W	N 112 E	N 77 W	N 68 W	N 19 W	N 119 W	N 89 W	N 74 W
1858	N 71 W	N 72 W	N 58 W	N 14 W	N 42 E	N 160 E	N 15 E	N 69 W	N 106 W	N 34 W	N 25 W	N 18 W	N 41 W
1859	N 99 W	N 54 W	N 64 W	N 36 W	N 72 E	N 77 W	N 56 W	N 36 W	N 44 W	N 68 W	N 81 W	N 53 W	N 61 W
1854 *to* 1859	N 77 W	N 67 W	N 70 W	N 23 W	N 20 E	N 73 W	N 66 W	N 58 W	N 61 W	N 62 W	N 85 W	N 70 W	N 62 W

RESULTANT VELOCITY.

	January.	February	March.	April.	May.	June.	July.	August.	September	October.	November.	December.	Year.
1854 *to* 1859	3.29	3.45	4.89	2.14	1.91	0.69	0.41	1.68	1.16	2.60	3.13	3.42	2.18

MEAN VELOCITY.

	January.	February	March.	April.	May.	June.	July.	August.	September	October.	November.	December.	Year.
1854 *to* 1859	8.56	8.87	9.86	8.50	7.37	5.91	5.44	6.24	5.96	6.81	9.15	9.75	7.70

TABLE II.

Monthly and Annual Resultant Direction of the Wind, for each hour of Toronto Astronomical Time, for the period 1854 to 1859 inclusive.

Hours commencing.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
0	N 84° W	N 83° W	N 83° W	N 111°w	N 107° E	N 158°w	N 180°w	N 142°w	N 146°w	N 86° W	N 91° W	N 73° W	N 103°w
1	N 86 W	N 82 W	N 84 W	N 110w	N 108 E	N 164w	N 175w	N 139w	N 142w	N 87 W	N 90 W	N 79 W	N 103w
2	N 87 W	N 81 W	N 83 W	N 97 W	N 80 E	N 168w	N 175w	N 123w	N 135w	N 84 W	N 90 W	N 81 W	N 101w
3	N 82 W	N 79 W	N 80 W	N 75 W	N 49 E	N 154w	N 176w	N 105w	N 120w	N 77 W	N 88 W	N 82 W	N 90 W
4	N 79 W	N 72 W	N 76 W	N 51 W	N 19 E	N 118w	N 153w	N 79 W	N 92 W	N 70 W	N 83 W	N 82 W	N 77 W
5	N 82 W	N 70 W	N 74 W	N 45 W	North	N 87 W	N 94 W	N 56 W	N 78 W	N 70 W	N 84 W	N 80 W	N 70 W
6	N 82 W	N 64 W	N 72 W	N 47 W	N 3 W	N 52 W	N 55 W	N 49 W	N 61 W	N 66 W	N 83 W	N 80 W	N 64 W
7	N 76 W	N 62 W	N 66 W	N 34 W	N 1 W	N 39 W	N 52 W	N 41 W	N 55 W	N 60 W	N 83 W	N 81 W	N 59 W
8	N 79 W	N 61 W	N 68 W	N 25 W	N 6 E	N 24 W	N 36 W	N 38 W	N 44 W	N 59 W	N 78 W	N 81 W	N 56 W
9	N 81 W	N 56 W	N 64 W	N 20 W	North	N 16 W	N 32 W	N 32 W	N 35 W	N 51 W	N 77 W	N 76 W	N 51 W
10	N 76 W	N 58 W	N 61 W	N 13 W	N 1 E	N 16 W	N 29 W	N 30 W	N 30 W	N 52 W	N 80 W	N 70 W	N 48 W
11	N 73 W	N 62 W	N 58 W	N 9 W	N 3 E	N 18 W	N 28 W	N 29 W	N 21 W	N 51 W	N 79 W	N 68 W	N 46 W
12	N 72 W	N 58 W	N 56 W	N 2 W	N 6 E	N 18 W	N 18 W	N 24 W	N 22 W	N 44 W	N 79 W	N 66 W	N 43 W
13	N 71 W	N 55 W	N 54 W	N 2 W	N 6 E	N 17 W	N 14 W	N 22 W	N 20 W	N 51 W	N 81 W	N 62 W	N 40 W
14	N 70 W	N 56 W	N 54 W	N 3 W	N 2 E	N 16 W	N 11 W	N 26 W	N 20 W	N 52 W	N 80 W	N 57 W	N 40 W
15	N 74 W	N 59 W	N 53 W	N 2 W	N 10 E	N 21 W	N 9 W	N 25 W	N 17 W	N 43 W	N 79 W	N 54 W	N 39 W
16	N 70 W	N 61 W	N 50 W	N 2 W	N 15 E	N 18 W	N 11 W	N 20 W	N 15 W	N 43 W	N 83 W	N 56 W	N 39 W
17	N 73 W	N 62 W	N 53 W	N 2 W	N 15 E	N 24 W	N 15 W	N 18 W	N 14 W	N 39 W	N 84 W	N 56 W	N 38 W
18	N 73 W	N 64 W	N 53 W	N 1 W	N 16 E	N 29 W	N 15 W	N 30 W	N 21 W	N 39 W	N 86 W	N 62 W	N 40 W
19	N 71 W	N 66 W	N 52 W	N 10 W	N 27 E	N 42w	N 14 W	N 38 W	N 36 W	N 45 W	N 82 W	N 56 W	N 42 W
20	N 68 W	N 65 W	N 53 W	N 9 W	N 29 E	N 67 W	N 19 W	N 55 W	N 49 W	N 50 W	N 83 W	N 59 W	N 48 W
21	N 69 W	N 68 W	N 62 W	N 12 W	N 36 E	N 126w	N 140w	N 74 W	N 78 W	N 58 W	N 87 W	N 59 W	N 63 W
22	N 75 W	N 72 W	N 72 W	N 40 W	N 61 E	N 145w	N 171 E	N 112w	N 121w	N 66 W	N 88 W	N 62 W	N 80 W
23	N 82 W	N 76 W	N 78 W	N 89 W	N 84 E	N 157w	N 173 E	N 138w	N 145w	N 79 W	N 92 W	N 67 W	N 96 W
Period of 24 hours.	N 77 W	N 67 W	N 70 W	N 23 W	N 20 E	N 73 W	N 66 W	N 58 W	N 61 W	N 62 W	N 85 W	N 70 W	N 62 W

TABLE III.

Monthly and Yearly Resultant Velocity of the Wind, for each hour of Toronto Astronomical Time, for the period 1854 to 1859 inclusive, the velocities being in miles per hour.

Hours.	Jan.	Feb.	March.	April.	May.	Ju ne.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
0	4.71	4.34	5.97	1.17	1.49	2.35	2.97	2.67	2.35	3.54	4.40	4.39	2.61
1	4.69	4.17	6.14	1.50	1.17	2.45	2.90	2.92	2.10	3.29	4.75	4.46	2.71
2	4.45	3.94	6.26	1.68	0.98	2.34	2.73	2.73	2.05	3.34	4.15	4.24	2.70
3	3.92	3.98	6.26	1.92	1.03	1.70	1.97	2.29	1.75	3.21	4.07	3.94	2.56
4	3.48	3.76	6.27	1.99	1.37	1.42	1.16	1.96	1.70	3.39	3.77	3.89	2.60
5	3.02	2.94	5.99	2.45	1.89	0.96	0.75	2.50	1.43	2.85	3.10	3.75	2.48
6	3.10	3.13	5.48	2.68	2.29	0.86	0.69	2.50	1.38	2.47	2.83	3.82	2.44
7	3.05	3.29	5.10	2.47	2.27	1.14	0.69	2.21	1.47	2.47	2.59	3.92	2.38
8	3.02	3.28	4.93	2.84	2.04	1.19	0.80	2.30	1.58	2.45	2.53	4.00	2.35
9	2.55	3.12	5.15	3.38	1.95	1.50	1.05	2.37	1.60	2.34	2.44	3.98	2.38
10	2.73	2.92	4.60	3.17	2.02	1.66	1.46	2.24	1.92	2.15	2.53	3.88	2.36
11	2.88	2.80	4.39	2.79	2.28	1.58	1.64	2.03	1.82	2.00	2.38	3.80	2.28
12	2.77	2.92	4.24	3.01	2.21	1.68	1.81	2 08	1.69	1.92	2.61	3.53	2.25
13	2.73	3.42	4.29	3.07	2.39	1.73	2.05	2.25	1.80	2.04	2.52	2.94	2.32
14	2.92	3.35	3.95	3.01	2.69	1.53	2.05	2.15	1.96	2.23	2.64	2.76	2.33
15	2.81	3.23	3.92	2.84	2.43	1.40	2.01	2.31	1.90	2.21	2.75	2.67	2.25
16	2.71	3.34	3.97	2.95	2.24	1.16	1.93	2.12	1.73	2.06	2.62	2.55	2.15
17	2.74	3.23	3.75	3.10	2.47	1.31	1.79	2.10	1.61	2.16	2.43	2.44	2.11
18	2.74	3.73	3.80	3.25	3.52	1.34	1.74	2.26	1.58	2.10	2.66	2.41	2.23
19	3.02	3.57	4.21	3.09	3.54	0.97	1.54	2.09	1.72	2.43	2.58	2.27	2.22
20	3.30	3.53	4.50	2.63	3.39	0.84	0.69	2.25	1.43	3.09	2.75	2.85	2.22
21	3.77	4.00	5.09	1.92	2.56	1.12	0.57	1.95	1.24	3.14	3.52	3.11	2.24
22	3.90	3.98	5.38	1.17	1.82	1.62	1.82	1.77	1.41	3.18	4.17	3.87	2.18
23	4.45	4.30	5.71	0.92	1.49	2.08	2.48	2.49	2.01	3.33	4.43	3.93	2.37
Period of 24 hours.	3.29	3.45	4 89	2.14	1.91	0.69	0.41	1.68	1.16	2.60	3.13	3.42	2.18

TABLE IV.

Monthly and Yearly Mean Velocity of the Wind, for each hour of Toronto Astronomical Time, for the period 1854 to 1859 inclusive, the velocities being in miles per hour.

Hours.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
0	10.43	10.69	12.09	11.29	10.33	8.80	8.76	8.99	9.27	10.33	11.57	10.97	10.29
1	10.54	10.54	12.29	11.12	10.28	9.06	8.52	9.45	8.94	10.22	11.79	11.05	10 32
2	10.45	10.13	12.50	10.99	10.05	8.89	8.74	9.72	9.21	9.98	11.86	10.69	10.27
3	9.86	9.95	12.28	10.66	9.67	8.85	8.18	9.52	8.80	9.39	10.94	10.02	9.84
4	9.23	9.72	12.56	10.43	9.41	8.57	7.63	9.11	7.86	8.50	10.28	9.97	9.44
5	8.63	8.54	11.18	9.13	8.02	7.25	6.39	7.84	6.09	6.65	9.06	9.60	8.20
6	8.66	8.57	10.24	8.15	6.99	5.98	5 01	6.41	5.09	5.87	8.83	9.64	7.45
7	8.73	8.88	9.87	7.17	6.23	4 88	3.68	5.16	4.64	5.77	8.27	9.63	6.91
8	8.38	8.99	9.41	7.22	5.91	4.41	3.31	4.95	4.45	5.73	8.31	9.63	6.72
9	7.74	8.08	9.22	7.06	5.26	4.19	3.39	4.63	4.68	5.29	8.02	9.23	6.40
10	7.91	7.69	8.53	6.82	5.06	4.17	3.82	4.62	4.66	5.42	7.98	9.44	6.34
11	7.76	7.73	8.28	6.58	5.13	3.94	3.61	4.08	4.29	5.08	7.93	9.70	6.18
12	7.90	7.84	8.12	6.58	4.92	4 11	4.00	3.98	4.09	4.92	7.95	9.63	6.17
13	7.65	8.19	8.04	6.56	4.99	3.84	3.82	4.16	4.40	5.00	7.82	9.21	6.14
14	7.48	8.11	7.85	6.82	5.34	3.82	4.07	4.18	4.48	5.41	7.89	9 43	6.24
15	7.42	7.86	7.93	6.71	5.03	3.77	3.83	4.29	4.39	5.25	8.13	9.48	6.17
16	7.49	8.13	8.32	6.67	4.97	3.93	3.65	4.15	4.16	5.09	8.26	9.14	6.16
17	7.32	7.99	8.12	7.06	5.42	4.01	3.58	4.24	4.19	5.17	8.09	9.22	6.20
18	7.94	8.62	8.36	7.50	7.27	4.61	4.01	4.56	4.29	4.91	8.08	9.25	6.62
19	7.65	8.06	8.64	8.44	8.03	5.10	4.72	4.79	5.11	5.50	7.91	8.49	6.87
20	8.08	8.57	9.45	9.31	9.02	6.17	5.73	6.43	6.04	6.87	8.70	9.57	7.83
21	8.83	9.55	10.44	9.77	9.47	7.01	6.70	7.31	7.28	8.10	9.61	9.95	8.67
22	9.35	10.13	11.17	10.81	9.91	8.04	7.38	8.15	7.99	9.03	10.82	10.48	9.44
23	9.90	10.32	11.75	11.27	10.25	8.56	7.97	9.00	8.72	9.83	11.45	10.50	9.96
Period of 24 hours.	8.56	8.87	9.86	8.50	7.37	5.91	5.44	6.24	5.96	6.81	9.15	9.75	7.70

TABLE V.

Mean Velocity of the Wind, arranged according to its direction, for the period 1853 to 1859 inclusive.

Direction	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.
Velocity	7.31	6.03	6.92	8.77	8.40	6.05	5.22	5.73
Direction	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.
Velocity	6.53	7.46	8.05	9.85	10.72	10.89	10.90	9.63

TABLE VI.

Ratios shewing the comparative duration of different winds, in the whole year as well as in each separate month, being the absolute durations of the different winds in the year or month, expressed in terms of the annual or monthly mean duration of all winds.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
N.	1.15	1.24	0.68	1.29	1.31	0.91	1.06	1.20	1.20	0.99	0.75	1.29	1.09
N.N.E.	0.74	0.85	0.33	0.96	0.50	0.44	0.70	0.85	0.84	0.66	0.65	1.10	0.72
N.E.	0.96	0.73	0.34	0.84	0.71	0.66	0.59	0.65	0.78	0.85	0.68	1.02	0.73
E.N.E.	0.72	0.68	1.10	1.40	1.90	1.34	1.10	0.77	1.04	1.02	1.21	0.86	1.09
E.	0.75	0.96	1.01	1.71	2.08	1.85	1.40	1.10	1.14	1.12	1.47	0.72	1.28
E.S.E.	0.44	0.37	0.44	0.89	1.03	0.84	0.99	0.66	0.64	0.47	0.49	0.42	0.64
S.E.	0.23	0.20	0.46	0.48	0.56	0.51	0.72	0.75	0.69	0.22	0.43	0.22	0.46
S.S.E.	0.21	0.28	0.24	0.52	0.57	0.59	1.18	0.67	0.72	0.45	0.43	0.19	0.50
S.	0.25	0.37	0.47	0.75	1.08	1.40	1.39	1.15	0.96	0.91	0.42	0.18	0.78
S.S.W.	0.78	1.00	0.90	1.03	1.30	1.63	1.61	1.27	1.50	1.05	0.86	0.49	1.12
S.W.	1.58	1.18	1.39	0.73	0.70	1.35	0.72	0.83	0.98	1.01	1.50	1.42	1.12
W.S.W	2.61	2.01	1.27	0.71	0.36	0.60	0.46	0.51	0.65	0.90	2.08	2.61	1.23
W.	1.78	2.08	1.81	0.93	0.49	0.90	0.53	0.92	0.78	1.35	1.78	1.98	1.28
W NW	1.00	1.47	2.27	1.13	0.79	0.84	0.86	1.38	1.05	1.67	1.34	1.11	1.24
N.W.	1.18	1.19	2.05	1.12	0.97	1.20	1.00	1.49	1.12	1.37	1.01	1.08	1.23
N.N W	1.38	1.58	1.44	1.51	1.69	1.18	1.48	1.69	1.35	1.29	1.03	1.29	1.41
Calms.	1.23	0.83	0.80	1.00	0.96	0.76	1.22	1.11	1.56	1.67	0.89	1.02	1.09

TABLE VII.

Ratios shewing the comparative durations of each separate wind in the different months, being the numbers in Table VI. expressed in terms of the Annual Means.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
N.	1.06	1.14	0.62	1.18	1.20	0.84	0.97	1.10	1.10	0.91	0.69	1.18
N.N.E.	1.03	1.18	0.46	1.34	0.70	0.61	0.98	1.18	1 17	0.92	0.90	1.53
N.E.	1.31	1.00	0.46	1.14	0.97	0.90	0.80	0.88	1.06	1.16	0.93	1.39
E N.E.	0.66	0.62	1.00	1.28	1.74	1.22	1.00	0.70	0.95	0.93	1.11	0.79
E.	0.59	0.75	0.79	1.34	1.63	1.45	1.09	0.86	0.89	0.88	1.15	0.56
E.S.E.	0.69	0.58	0.69	1.39	1.61	1.31	1.55	1.03	1.00	0.73	0.77	0.66
S.E.	0.50	0.44	1.00	1.05	1.24	1.12	1.58	1.65	1.51	0.48	0.94	0.48
S.S.E.	0.42	0.56	0.48	1.03	1.13	1.17	2.34	1.33	1.43	0.89	0.85	0.38
S.	0.32	0.48	0.60	0.97	1.38	1.82	1.78	1.49	1.23	1.18	0.54	0.23
S.S.W.	0.70	0.89	0.80	0.92	1.16	1.46	1.44	1.13	1.34	0.94	0.77	0.44
S.W.	1.42	1.06	1.25	0.65	0.63	1.21	0.64	0.74	0.88	0.91	1.34	1.27
W.S.W	2.12	1.63	1.03	0.58	0.29	0.49	0.37	0.41	0.53	0.73	1.69	2.12
W.	1.39	1.63	1.41	0.73	0.38	0.70	0.41	0.72	0 61	1.06	1.39	1.55
W.NW	0.81	1.19	1.83	0.91	0.64	0.68	0.69	1.11	0.85	1.31	1.08	0.90
N.W.	0.96	0.97	1.67	0.91	0.79	0.97	0.81	1.21	0.91	1.11	0.82	0.88
N.N W	0.98	1.12	1.02	1.07	1.20	0.84	1.05	1.20	0.96	0.91	0.73	0,92
Calms.	1.13	0.76	0.73	0.92	0.88	0.70	1.20	1.02	1.43	1.53	0.82	0.94

TABLE

Ratios shewing the comparative duration of different winds at each separate duration of all winds

Toronto Astronomical time.	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.
0	0.61	0.33	0.43	0.86	1.61	1.02	0.78	0.96	1.65
1	0.55	0.28	0.44	0.93	1.54	1.04	0.80	0.99	1.65
2	0.50	0.29	0.43	0.86	1.78	1.05	0.70	0.94	1.62
3	0.54	0.28	0.39	0.96	1.76	1.12	0.69	0.96	1.31
4	0.61	0.31	0.45	1.01	1.84	1.00	0.71	0.81	1.16
5	0.74	0.34	0.53	1.14	1.72	0.86	0.54	0.75	1.00
6	0.70	0.40	0.59	1.30	1.58	0.67	0.46	0.66	0.97
7	0.83	0.44	0.68	1.32	1.38	0.71	0.38	0.51	0.71
8	0.94	0.53	0.66	1.24	1.30	0.51	0.46	0.39	0.54
9	1.08	0.68	0.73	1.22	1.18	0.46	0.33	0.41	0.44
10	1.27	0.80	0.77	1.22	1.04	0.43	0.37	0.35	0.40
11	1.46	0.88	0.85	1.00	1.05	0.41	0.38	0.31	0.39
12	1.59	0.97	0.86	1.08	0.88	0.41	0.31	0.25	0.37
13	1.54	1.14	0.98	1.01	0.79	0.35	0.31	0.25	0.39
14	1.62	1.26	1.02	0.98	0.84	0.35	0.27	0.23	0.37
15	1.72	1.24	0.97	1.01	0.82	0.34	0.27	0.21	0.42
16	1.66	1.18	0.98	1.12	0.76	0.33	0.21	0.27	0.35
17	1.62	1.18	1.03	1.16	0.77	0.34	0.19	0.33	0.37
18	1.54	1.17	1.07	1.13	0.86	0.33	0.24	0.29	0.39
19	1.46	1.07	1.02	1.18	1.07	0.35	0.27	0.24	0.41
20	1.19	0.86	0.92	1.34	1.36	0.54	0.35	0.27	0.44
21	0.96	0.64	0.84	1.18	1.55	0.75	0.46	0.37	0.66
22	0.79	0.53	0.53	1.04	1.57	0.93	0.70	0.62	1.12
23	0.62	0.43	0.44	0.96	1.52	1.06	0.80	0.78	1.52

VIII.

hour, being the absolute durations at the hour expressed in terms of the Mean at the same hour.

S.S.W.	S.W.	W.S.W.	W.	W.N.W	N.W.	N.N.W.	CALMS.	Toronto Astronomical time.
1.82	1.16	1.05	1.23	1.14	1.10	1.00	0.25	0
1.87	1.16	1.12	1.19	1.12	1.14	0.96	0.22	1
1.91	1.04	1.16	1.23	1.08	1.04	1.08	0.27	2
1.83	1.11	1.12	1.23	1.08	1.05	1.22	0.36	3
1.57	1.21	1.09	1.22	1.06	1.12	1.27	0.55	4
1.48	1.30	1.11	1.13	1.20	1.04	1.28	0.86	5
1.24	1.34	1.20	1.13	1.13	1.29	1.35	0.99	6
1.11	1.37	1.28	1.10	1.31	1.21	1.55	1.11	7
0.87	1.36	1.34	1.29	1.25	1.22	1.66	1.46	8
0.77	1.06	1.35	1.29	1.31	1.31	1.69	1.68	9
0.68	1.00	1.34	1.46	1.28	1.24	1.67	1.67	10
0.74	0.94	1.38	1.40	1.22	1.30	1.66	1.63	11
0.68	0.95	1.34	1.34	1.26	1.29	1.59	1.82	12
0.65	0.90	1.40	1.30	1.22	1.35	1.61	1.80	13
0.74	0.90	1.38	1.24	1.35	1.44	1.52	1.49	14
0.68	0.95	1.26	1.23	1.38	1.35	1.62	1.52	15
0.67	0.99	1.22	1.28	1.48	1.28	1.65	1.56	16
0.65	0.92	1.22	1.33	1.38	1.33	1.70	1.47	17
0.69	1.05	1.14	1.22	1.38	1.31	1.60	1.60	18
0.75	1.08	1.22	1.34	1.32	1.25	1.48	1.49	19
0.96	1.25	1.26	1.42	1.24	1.25	1.48	0.96	20
1.28	1.29	1.26	1.40	1.28	1.31	1.12	0.64	21
1.55	1.22	1.21	1.29	1.20	1.24	1.06	0.41	22
1.69	1.17	1.05	1.26	1.12	1.14	1.06	0.39	23

TABLE

Ratios shewing the comparative duration of each separate wind in the different duration of the same

Toronto Astronomical time.	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.
0	0.56	0.46	0.59	0.79	1.26	1.59	1.71	1.90	2.12
1	0.51	0.39	0.61	0.85	1.21	1.62	1.75	1.96	2.12
2	0.46	0.40	0.59	0.79	1.40	1.64	1.53	1.86	2.08
3	0.50	0.39	0.53	0.88	1.38	1.75	1.51	1.90	1.70
4	0.56	0.43	0.61	0.92	1.44	1.56	1.55	1.60	1.49
5	0.68	0.47	0.72	1.04	1.34	1.34	1.18	1.48	1.29
6	0.64	0.56	0.80	1.19	1.24	1.05	1.01	1.30	1.25
7	0.76	0.61	0.93	1.21	1.08	1.11	0.83	1.01	0.91
8	0.86	0.74	0.90	1.13	1.02	0.80	1.01	0.77	0.69
9	0.99	0.94	0.99	1.12	0.96	0.72	0.72	0.81	0.57
10	1.17	1.11	1.05	1.12	0.82	0.67	0.80	0.69	0.51
11	1.34	1.23	1.16	0.91	0.82	0.64	0.83	0.61	0.50
12	1.46	1.35	1.17	0.99	0.69	0.64	0.67	0.49	9.48
13	1.41	1.59	1.34	0.92	0.62	0.55	0.67	0.49	0.50
14	1.49	1.75	1.39	0.90	0.66	0.55	0.59	0.45	0.48
15	1.58	1.73	1.32	0.92	0.60	0.53	0.59	0.41	0.54
16	1.52	1.64	1.34	1.02	0.60	0.52	0.46	0.53	0.44
17	1.49	1.64	1.40	1.06	0.60	0.53	0.41	0.65	0.47
18	1.41	1.63	1.46	1.03	0.68	0.51	0.52	0.57	0.50
19	1.34	1.49	1.39	1.08	0.84	0.55	0.59	0.47	0.53
20	1.09	1.20	1.25	1.23	1.07	0.84	0.77	0.53	0.57
21	0.88	0.89	1.14	1.08	1.22	1.17	1.01	0.73	0.85
22	0.73	0.74	0.72	0.95	1.23	1.45	1.53	1.23	0.44
23	0.57	0.60	0.61	0.88	1.19	1.66	1.75	1.54	1.96

IX.

hours, being the absolute durations at the hour expressed, in terms of the Mean wind for all hours.

S.S.W.	S.W.	W.S.W.	W.	W.N.W	N.W.	N.N.W.	Calms.	Toronto Astronomical time.
1.62	1.04	0.85	0.97	0.92	0.89	0.71	0.23	0
1.67	1.04	0.91	0.94	0.90	0.93	0.68	0.20	1
1.70	0.93	0.95	0.97	0.87	0.85	0.77	0.25	2
1.63	1.00	0.91	0.97	0.87	0.85	0.87	0.33	3
1.40	1.09	0.89	0.96	0.85	0.91	0.90	0.50	4
1.32	1.17	0.90	0.89	0.97	0.85	0.91	0.79	5
1.11	1.20	0.98	0.89	0.91	1.04	0.96	0.90	6
0.99	1.23	1.04	0.87	1.06	0.98	1.10	1.02	7
0.78	1.22	1.09	1.02	1.01	0.99	1.18	1.34	8
0.69	0.95	1.10	1.02	1.05	1.06	1.20	1.54	9
0.61	0.90	1.09	1.18	1.03	1.01	1.19	1.53	10
0.66	0.84	1.12	1.06	0.98	1.06	1.18	1.49	11
0.61	0.85	1.09	1.03	1.01	1.04	1.13	1.67	12
0.58	0.81	1.14	0.98	0.98	1.09	1.14	1.65	13
0.66	0.81	1.12	0.97	1.09	1.17	1.08	1.36	14
0.61	0.85	1.03	0.97	1.11	1.09	1.15	1.39	15
0.60	0 89	0.99	1.01	1.19	1.04	1.17	1.43	16
0.58	0.83	0.99	1.05	1.11	1.08	1.20	1.35	17
0.62	0.94	0.93	0.96	1.11	1.06	1.13	1.47	18
0.67	0.97	0.99	1.06	1.07	1.01	1.05	1.37	19
0.86	1.12	1.03	1.12	1.00	1.01	0.99	0.88	20
1.14	1.16	1.03	1.10	1.03	1.06	0.80	0.59	21
1.38	1.10	0.98	1.02	0.97	1.01	0.75	0.38	22
1.51	1.05	0.85	1.00	0.90	0.93	0.75	0.36	23

A NEW PROOF OF THE EXISTENCE OF THE ROOTS OF EQUATIONS.

BY THE REV. GEORGE PAXTON YOUNG, M.A., TORONTO.

The equation of the m^{th} degree,

$$f(x)=x^m+a_1x^{m-1}+\cdots\cdots\cdots+a_m=0, \qquad (1)$$

has a root. For, y and z being real variables,

$$f(y+\sqrt{-1}z)=P(\cos\lambda+\sqrt{-1}\sin\lambda);$$

where P and λ are real. When y and z receive the definite values y_1 and z_1, let P and λ become P_1 and λ_1 respectively; and let P_1^2 be the least possible value of P^2. Then $y_1+\sqrt{-1}\,z_1$, or, as we may call it, x_1, is a root of the equation,

$$f(x)-P_1(\cos\lambda_1+\sqrt{-1}\sin\lambda_1)=0. \qquad (2)$$

Let n be the greatest number of roots equal to x_1 which this equation has. Then $f(x)-P_1(\cos\lambda_1+\sqrt{-1}\sin\lambda_1)$ is divisible by $(x-x_1)^n$ without remainder: which we may express by putting

$$f(x)-P_1(\cos\lambda_1+\sqrt{-1}\sin\lambda_1)=(x-x_1)^n\left\{F(x)\right\}. \qquad (3)$$

Take $x_2=x_1+k(\cos\phi+\sqrt{-1}\sin\phi)=x_1+h$. Then

$$F(x_2)=F(x_1)+X_1h+X_2h^2+\&c.;$$

where X_1, X_2, &c., are clear of h. In order to separate the real from the imaginary parts in the value of $F(x_2)$, put

$$F(x_1)=A(\cos\theta+\sqrt{-1}\sin\theta),\ X_1=B(\cos\psi+\sqrt{-1}\sin\psi),$$

and so on. Since equation (3) is independent of the particular value of x, we may substitute x_2 for x in that equation. Then

$$\begin{aligned} f(x_2)&=P_1(\cos\lambda_1+\sqrt{-1}\sin\lambda_1)+h^n\left\{F(x_1)+X_1h+\&c.\right\}\\ &=P_1\cos\lambda_1+k^nA\cos(n\phi+\theta)+\ldots\ldots\\ &\quad+\sqrt{-1}\left\{P_1\sin\lambda_1+k^nA\sin(n\phi+\theta)+\&c\right\}. \end{aligned}$$

By putting $S = k^n A \cos(n\phi+\theta)+\&c$, and $T=k^n A \sin(n\phi+\theta)+\&c$, this becomes

$$f(x_2) = (P_1 \cos\lambda_1 + S) + \sqrt{-1}\,(P_1 \sin\lambda_1 + T);$$

which again if $P_2^2=(P_1\cos\lambda_1+S)^2+(P_1\sin\lambda_1+T)^2$, may be written

$$f(x_2) = P_2(\cos\beta + \sqrt{-1}\sin\beta).$$

Since P_2^2 is a particular value of P^2, and since the least value of P^2 is P_1^2, $P_2^2-P_1^2$ cannot be negative. But

$$\begin{aligned} P_2^2-P_1^2 &= 2\,P_1(S\cos\lambda_1+T\sin\lambda_1)+S^2+T^2 \\ &= 2\,k^n AP_1 \cos(n\phi+\theta-\lambda_1)+\&c. \quad\text{———————}(4) \end{aligned}$$

We give only the first term in the expansion of $P_2^2-P_1^2$ according to the ascending powers of k. The other terms contain powers of k higher than the n^{th}. Now suppose if possible that P_1 is not zero. From the manner in which $F(x)$ was taken in equation (3), $F(x_1)$ is not zero; for if it were, $F(x)$ would be divisible by $x-x_1$, and therefore there would be more than n roots of equation (2) equal to x_1: which we supposed not to be the case. Hence A also, which is a factor of $F(x_1)$, is distinct from zero. Take then $n\phi$ such [θ and λ_1 being determined, the former from $F(x_1)$, and the latter from $f(x_1)$] that $\cos(n\phi+\theta-\lambda_1)$ may be distinct from zero, and have its sign opposite to that of AP_1. Then cause k, always remaining positive, to approach indefinitely near to zero; till the sign of the whole expression for $P_2^2-P_1^2$ in (4) is the same with that of its first term. The sign of that first term is necessarily negative. Therefore the sign of $P_2^2-P_1^2$ is ultimately negative: which, however, we have seen to be impossible. Therefore P_1 cannot but be zero. Hence $f(x_1)$ is zero; and x_1 is a root of equation (1).

PROCEEDINGS OF THE BRITISH ASSOCIATION.

For the following valuable extracts from the proceedings of the British Association for the Advancement of Science, we are indebted to the Reports of the London *Athenæum*. The Association met at Newcastle, under the Presidency of Sir Wm. Armstrong.

EXTRACTS FROM THE PRESIDENT'S ADDRESS.

The history of railways shows what grand results may have their origin in small beginnings. When coal was first conveyed in this neighbourhood from the pit to the shipping-place on the Tyne, the pack-horse, carryiug a burden of 3 cwt., was the only mode of transport employed. As soon as roads suitable for wheeled carriages were formed, carts were introduced, and this first step in mechanical appliance to facilitate transport had the effect of increasing the load which the horse was enabled to convey from 3 cwt. to 17 cwt. The next improvement consisted in laying wooden bars or rails for the wheels of the carts to run upon, and this was followed b the substitution of the four-wheeled waggon for the two-wheeled cart. By this further application of mechanical principles the original horse load of 3 cwt. was augmented to 42 cwt. These were important results, and they were not obtained without the shipwreck of the fortunes of at least one adventurous man whose ideas were in advance of the times in which he lived. We read, in a record published in the year 1649, that "one Master Beaumont, a gentleman of great ingenuity and rare parts, adventured into the mines of Northumberland with his 30,000l., and brought with him many rare engines not then known in that shire, and waggons with one horse to carry down coal from the pits to the river, but within a few years he consumed all his money and rode home upon his light horse." The next step in the progress of railways was the attachment of slips of iron to the wooden rails. Then came the iron tramway, consisting of cast-iron bars of an angular section: in this arrangement the upright flange of the bar acted as a guide to keep the wheel on the track. The next advance was an important one, and consisted in transferring the guiding flange from the rail to the wheel; this improvement enabled cast-iron edge rails to be used. Finally, in 1820, after the lapse of about 200 years from the first employment of wooden bars, wrought-iron rails, rolled in long lengths, and of suitable section, were made in this neighbourhood, and eventually superseded all other forms of railway. Thus, the railway system, like all large inventions, has risen to its present importance by a series of steps; and so gradual has been its progress, that Europe finds itself committed to a gauge fortuitously determined by the distance between the wheels of the carts for which wooden rails were originally laid down.

Last of all came the locomotive engine, that crowning achievement of mechanical science, which enables us to convey a load of 200 tons at a cost of fuel

scarcely exceeding that of the corn and hay which the original pack-horse consumed in conveying its load of 3 cwt. an equal distance.

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In thus glancing at the history of railways, we may observe how promptly the inventive faculty of man supplies the device which the circumstances of the moment require. No sooner is a road formed fit for wheeled carriages to pass along, than the cart takes the place of the pack-saddle: no sooner is the wooden railway provided than the waggon is substituted for the cart: and no sooner is an iron railway formed, capable of carrying heavy loads, than the locomotive engine is found ready to commence its career. As in the vegetable kingdom fit conditions of soil and climate quickly cause the appearance of suitable plants, so in the intellectual world fitness of time and circumstance promptly calls forth appropriate devices. The seeds of invention exist, as it were, in the air, ready to germinate whenever suitable conditions arise, and no legislative interference is needed to insure their growth in proper season.

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To persons who contend that all geological phenomena may be attributed to causes identical in nature and degree with those now in operation, the formation of coal must present peculiar difficulty. The rankness of vegetation which must have existed in the carboniferous era, and the uniformity of climate which appears to have prevailed almost from the Poles to the Equator, would seem to imply a higher temperature of the earth's crust, and an atmosphere more laden with humidity and carbonic acid than exist in our day. But whatever may have been the geological conditions affecting the origin of coal, we may regard the deposits of that mineral as vast magazines of power stored up at periods immeasurably distant for our use.

The principle of conservation of force, and the relationship now established between heat and motion, enable us to trace back the effects which we now derive from coal to equivalent agencies exercised at the periods of its formation. The philosophical mind of George Stephenson, unaided by theoretical knowledge, rightly saw that coal was the embodiment of power originally derived from the sun. That small pencil of solar radiation which is arrested by our planet, and which constitutes less than the 2,000-millionth part of the total energy sent forth from the sun, must be regarded as the power which enabled the plants of the carboniferous period to wrest the carbon they required from the oxygen with which it was combined, and eventually to deposit it as the solid material of coal. In our day, the reunion of that carbon with oxygen restores the energy expended in the former process, and thus we are enabled to utilize the power originally derived from the luminous centre of our planetary system.

But the agency of the sun in originating coal does not stop at this point. In every period of geological history the waters of the ocean have been lifted by the action of the sun and precipitated in rain upon the earth. This has given rise to all those sedimentary actions by which mineral substances have been collected at particular localities, and there deposited in a stratified form with a protecting cover to preserve them for future use. The phase of the earth's existence suitable for the extensive formation of coal appears to have passed away for ever; but

the quantity of that invaluable mineral which has been stored up throughout the globe for our benefit is sufficient (if used discreetly) to serve the purposes of the human race for many thousands of years. In fact, the entire quantity of coal may be considered as practically inexhaustible. Turning, however, to our own particular country, and contemplating the rate at which we are expending those seams of coal which yield the best quality of fuel, and can be worked at the least expense, we shall find much cause for anxiety. The greatness of England much depends upon the superiority of her coal in cheapness and quality over that of other nations; but we have already drawn from our choicest mines a far larger quantity of coal than has been raised in all other parts of the world put together, and the time is not remote when we shall have to encounter the disadvantages of increased cost of working and diminished value of produce.

Estimates have been made at various periods of the time which would be required to produce complete exhaustion of all the accessible coal in the British Islands. These estimates are extremely discordant; but the discrepancies arise, not from any important disagreement as to the available quantity of coal, but from the enormous difference in the rate of consumption at the various dates when the estimates were made, and also from the different views which have been entertained as to the probable increase of consumption in future years. The quantity of coal yearly worked from British mines has been almost trebled during the last twenty years, and has probably increased tenfold since the commencement of the present century; but as this increase has taken place pending the introduction of steam navigation and railway transit, and under exceptional conditions of manufacturing development, it would be too much to assume that it will continue to advance with equal rapidity. The statistics collected by Mr. Hunt, of the Mining Records Office, show that at the end of 1861 the quantity of coal raised in the United Kingdom had reached the enormous total of 86 millions of tons, and that the average annual increase of the eight preceding years amounted to 2¾ millions of tons. Let us inquire, then, what will be the duration of our coal-fields if this more moderate rate of increase be maintained.

By combining the known thickness of the various workable seams of coal, and computing the area of the surface under which they lie, it is easy to arrive at an estimate of the total quantity comprised in our coal-bearing strata. Assuming 4,000 feet as the greatest depth at which it will ever be possible to carry on mining operations, and rejecting all seams of less than two feet in thickness, the entire quantity of available coal existing in these islands has been calculated to amount to about 80,000 millions of tons, which, at the present rate of consumption, would be exhausted in 930 years, but, with a continued yearly increase of 2¾ millions of tons, would only last 212 years. It is clear that long before complete exhaustion takes place, England will have ceased to be a coal-producing country on an extensive scale. Other nations, and especially the United States of America, which possess coal-fields thirty-seven times more extensive than ours, will then be working more accessible beds at a smaller cost, and will be able to displace the English coal from every market. The question is, not how long our coal will endure before absolute exhaustion is effected, but how long will those particular coal-seams last which yield coal of a quality and at a price to enable

this country to maintain her present supremacy in manufacturing industry. So far as this particular district is concerned, it is generally admitted that 200 years will be sufficient to exhaust the principal seams even at the present rate of working. If the production should continue to increase, as it is now doing, the duration of those seams will not reach half that period. How the case may stand in other coal-mining districts I have not the means of ascertaining; but as the best and most accessible coal will always be worked in preference to any other, I fear the same rapid exhaustion of our most valuable seams is everywhere taking place. Were we reaping the full advantage of all the coal we burnt, no objection could be made to the largeness of the quantity, but we are using it wastefully and extravagantly in all its applications. It is probable that fully one-fourth of the entire quantity of coal raised from our mines is used in the production of heat for motive power; but, much as we are in the habit of admiring the powers of the steam-engine, our present knowledge of the mechanical energy of heat shows that we realize in that engine only a small part of the thermic effect of the fuel. That a pound of coal should, in our best engines, produce an effect equal to raising a weight of a million pounds a foot high, is a result which bears the character of the marvellous, and seems to defy all further improvement. Yet the investigations of recent years have demonstrated the fact that the mechanical energy resident in a pound of coal, and liberated by its combustion, is capable of raising to the same height 10 times that weight. But although the power of our most economical steam-engines has reached, or perhaps somewhat exceeded, the limit of a million pounds raised a foot high per lb. of coal, yet, if we take the average effect obtained from steam-engines of the various constructions now in use, we shall not be justified in assuming it at more than one-third of that amount. It follows, therefore, that the average quantity of coal which we expend in realizing a given effect by means of the steam-engine is about 30 times greater than would be requisite with an absolutely perfect heat-engine.

The causes which render the application of heat so uneconomic in the steam-engine have been brought to light by the discovery of the dynamical theory of heat; and it now remains for mechanicians, guided by the light they have thus received, to devise improved practical methods of converting the heat of combustion into available power.

Engines in which the motive power is excited by the communication of heat to fluids already existing in the aëriform condition, as in those of Stirling, Ericsson and Siemens, promise to afford results greatly superior to those obtained from the steam-engine. They are all based upon the principle of employing fuel to generate sensible heat, to the exclusion of latent heat, which is only another name for heat which has taken the form of unprofitable motion amongst the particles of the fluid to which it is applied. They also embrace what is called the regenerative principle—a term which has, with reason, been objected to, as implying a restoration of expended heat. The so-called "regenerator" is a contrivance for arresting unutilized heat rejected by the engine, and causing it to operate in aid and consequent reduction of fuel.

It is a common observation that before coal is exhausted some other motive agent will be discovered to take its place, and electricity is generally cited as the coming power. Electricity, like heat, may be converted into motion, and both

theory and practice have demonstrated that its mechanical application does not involve so much waste of power as takes place in a steam-engine; but whether we use heat or electricity as a motive power, we must equally depend upon chemical affinity as the source of supply. The act of uniting to form a chemical product liberates an energy which assumes the form of heat or electricity, from either of which states it is convertible into mechanical effect. In contemplating, therefore, the application of electricity as a motive power, we must bear in mind that we shall still require to effect chemical combinations, and in so doing to consume materials. But where are we to find materials so economical for this purpose as the coal we derive from the earth and the oxygen we obtain from the air? The latter costs absolutely nothing; and every pound of coal, which in the act of combustion enters into chemical combination, renders more than two-and-a-half pounds of oxygen available for power. We cannot look to water as a practical source of oxygen, for there it exists in the combined state, requiring expenditure of chemical energy for its separation from hydrogen. It is in the atmosphere alone that it can be found in that free state in which we require it, and there does not appear to me to be the remotest chance, in an economic point of view, of being able to dispense with the oxygen of the air as a source either of thermo-dynamic or electro-dynamic effect. But to use this oxygen we must consume some oxidizable substance, and coal is the cheapest we can procure.

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I have hitherto spoken of coal only as a source of mechanical power, but it is also extensively used for the kindred purpose of relaxing those cohesive forces which resist our efforts to give new forms and conditions to solid substances. In these applications, which are generally of a metallurgical nature, the same wasteful expenditure of fuel is everywhere observable. In an ordinary furnace employed to fuse or soften any solid substance, it is the excess of the heat of combustion over that of the body heated which alone is rendered available for the purpose intended. The rest of the heat, which in many instances constitutes by far the greater proportion of the whole, is allowed to escape uselessly into the chimney. The combustion also in common furnaces is so imperfect, that clouds of powdered carbon, in the form of smoke, envelope our manufacturing towns, and gases, which ought to be completely oxygenized in the fire, pass into the air with two-thirds of their heating power undeveloped.

Some remedy for this state of things, we may hope, is at hand, in the gas regenerative furnaces recently introduced by Mr. Siemens. In these furnaces the rejected heat is arrested by a so-called "regenerator," as in Stirling's air-engine, and is communicated to the new fuel before it enters the furnace. The fuel, however, is not solid coal, but gas previously evolved from coal. A stream of this gas raised to a high temperature by the rejected heat of combustion is admitted into the furnace, and there meets a stream of atmospheric air also raised to a high temperature by the same agency. In the combination which then ensues, the heat evolved by the combustion is superadded to the heat previously acquired by the gases. Thus, in addition to the advantage of economy, a greater intensity of heat is attained than by the combustion of unheated fuel. In fact, as the heat evolved in the furnace, or so much of it as is not communicated to the bodies exposed to its action, continually returns to augment the effect of the new

fuel, there appears to be no limit to the temperature attainable, except the powers of resistance in the materials of which the furnace is composed.

With regard to smoke, which is at once a waste and a nuisance, having myself taken part with Dr. Richardson and Mr. Longridge in a series of experiments made in this neighbourhood in the years 1857–58 for the purpose of testing the practicability of preventing smoke in the combustion of bituminous coal in steam engine boilers, I can state with perfect confidence that, so far as the raising of steam is concerned, the production of smoke is unnecessary and inexcusable. The experiments to which I refer proved beyond a doubt, that by an easy method of firing, combined with a due admission of air and a proper arrangement of fire-grate, not involving any complexity, the emission of smoke might be perfectly avoided, and that the prevention of the smoke increased the economic value of the fuel and the evaporative power of the boiler. As a rule, there is more smoke evolved from the fires of steam-engines than from any others, and it is in these fires that it may be most easily prevented. But in the furnaces used for most manufacturing operations the prevention of smoke is much more difficult, and will probably not be effected until a radical change is made in the system of applying fuel for such operations.

Not less wasteful and extravagant is our mode of employing coal for domestic purposes. It is computed that the consumption of coal in dwelling-houses amounts in this country to a ton per head per annum of the entire population; so that upwards of twenty-nine millions of tons are annually expended in Great Britain alone for domestic use. If any one will consider that one pound of coal applied to a well-constructed steam-engine boiler evaporates 10 lb., or one gallon of water, and if he will compare this effect with the insignificant quantity of water which can be boiled off in steam by a pound of coal consumed in an ordinary kitchen fire, he will be able to appreciate the enormous waste which takes place by the common method of burning coal for culinary purposes. The simplest arrangements to confine the heat and concentrate it upon the operation to be performed would suffice to obviate this reprehensible waste. So also in warming houses we consume in our open fires about five times as much coal as will produce the same heating effect when burnt in a close and properly constructed stove. Without sacrificing the luxury of a visible fire, it would be easy, by attending to the principles of radiation and convection, to render available the greater part of the heat which is now so improvidently discharged into the chimney. These are homely considerations—too much so, perhaps, for an assembly like this; but I trust that an abuse involving a useless expenditure exceeding in amount our income-tax, and capable of being rectified by attention to scientific principles, may not be deemed unworthy of the notice of some of those whom I have the honour of addressing.

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The increase of the earth's temperature as we descend below the surface is a subject which has been discussed at previous Meetings of the British Association. It possesses great scientific interest as affecting the computed thickness of the crust which covers the molten mass assumed to constitute the interior portions of the earth, and it is also of great practical importance as determining the depth at which it would be possible to pursue the working of coal and other minerals.

The deepest coal-mine in this district is the Monkwearmouth Colliery, which reaches a depth of 1,800 feet below the surface of the ground, and nearly as much below the level of the sea. The observed temperature of the strata at this depth agrees pretty closely with what has been ascertained in other localities, and shows that the increase takes place at the rate of 1° Fahr to about 60 feet of depth. Assuming the temperature of subterranean fusion to be 3,000°, and that the increase of heat at greater depths continues uniform (which, however, is by no means certain), the thickness of the film which separates us from the fiery ocean beneath will be about 34 miles—a thickness which may be fairly represented by the skin of a peach taken in relation to the body of the fruit which it covers. The depth of 4,000 feet, which has been assumed as the limit at which coal could be worked, would probably be attended by an increase of heat exceeding the powers of human endurance. In the Monkwearmouth Colliery, which is less than half that depth, the temperature of the air in the workings is about 84° Fahr. which is considered to be nearly as high as is consistent with the great bodily exertion necessary in the operation of mining. The computations, therefore, of the duration of coal would probably require a considerable reduction in consequence of too great a depth being assumed as practicable.

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In the course of the preceding observations I have had occasion to speak of the sun as the great source of motive power on our earth, and I must not omit to refer to recent discoveries connected with that most glorious body. Of all the results which science has produced within the last few years, none has been more unexpected than that by which we are enabled to test the materials of which the sun is made, and prove their identity, in part at least, with those of our planet. The spectrum experiments of Bunsen and Kirchhoff have not only shown all this, but they have also corroborated previous conjectures as to the luminous envelope of the sun. I have still to advert to Mr. Nasmyth's remarkable discovery, that the bright surface of the sun is composed of an aggregation of apparently solid forms, shaped like willow-leaves or some well known forms of Diatomaceæ, and interlacing one another in every direction. The forms are so regular in size and shape, as to have led to a suggestion from one of our profoundest philosophers of their being organisms, possibly even partaking of the nature of life, but at all events closely connected with the heating and vivifying influences of the sun. These mysterious objects, which, since Mr. Nasmyth discovered them, have been seen by other observers as well, are computed to be each not less than 1,000 miles in length and about 100 miles in breadth. The enormous chasms in the sun's photosphere, to which we apply the diminutive term "spots," exhibit the extremities of these leaf-like bodies pointing inwards, and fringing the sides of the cavern far down into the abyss. Sometimes they form a sort of rope or bridge across the chasm, and appear to adhere to one another by lateral attraction. I can imagine nothing more deserving of the scrutiny of observers than these extraordinary forms. The sympathy, also, which appears to exist between forces operating in the sun, and magnetic forces belonging to the earth merits a continuance of that close attention which it has already received from the British Association, and of labours such as General Sabine has with so much ability and effect devoted to the elucidation of the subject. I may here notice that most

remarkable phenomenon which was seen by independent observers at two different places on the 1st of September, 1859. A sudden outburst of light, far exceeding the brightness of the sun's surface, was seen to take place, and sweep like a drifting cloud over a portion of the solar face. This was attended with magnetic disturbances of unusual intensity and with exhibitions of aurora of extraordinary brilliancy. The identical instant at which the effusion of light was observed was recorded by an abrupt and strongly marked deflection in the self-registering instruments at Kew. The phenomenon as seen was probably only part of what actually took place, for the magnetic storm in the midst of which it occurred commenced before and continued after the event. If conjecture be allowable in such a case, we may suppose that this remarkable event had some connexion with the means by which the sun's heat is renovated. It is a reasonable supposition that the sun was at that time in the act of receiving a more than usual accession of new energy; and the theory which assigns the maintenance of its power to cosmical matter plunging into it with that prodigious velocity which gravitation would impress upon it as it approached to actual contact with the solar orb, would afford an explanation of this sudden exhibition of intensified light in harmony with the knowledge we have now attained that arrested motion is represented by equivalent heat. Telescopic observations will probably add new facts to guide our judgment on this subject, and, taken in connexion with observations on terrestrial magnetism, may enlarge and correct our views respecting the nature of heat, light and electricity. Much as we have yet to learn respecting these agencies, we know sufficient to infer that they cannot be transmitted from the sun to the earth except by communication from particle to particle of intervening matter. Not that I speak of particles in the sense of the atomist. Whatever our views may be of the nature of particles, we must conceive them as centres invested with surrounding forces. We have no evidence, either from our senses or otherwise, of these centres being occupied by solid cores of indivisible incompressible matter essentially distinct from force. Dr. Young has shown that even in so dense a body as water, these nuclei, if they exist at all, must be so small in relation to the intervening spaces, that a hundred men distributed at equal distances over the whole surface of England would represent their relative magnitude and distance. What then must be these relative dimensions in highly rarefied matter? But why encumber our conceptions of material forces by this unnecessary imagining of a central molecule? If we retain the forces and reject the molecule, we shall still have every property we can recognize in matter by the use of our senses or by the aid of our reason. Viewed in this light, matter is not merely a thing subject to force, but is itself composed and constituted of force.

The dynamical theory of heat is probably the most important discovery of the present century. We now know that each Fahrenheit degree of temperature in 1 lb. of water is equivalent to a weight of 772lb. lifted 1 foot high, and that these amounts of heat and power are reciprocally convertible into one another. This theory of heat, with its numerical computation, is chiefly due to the labours of Mayer and Joule, though many other names, including those of Thomson and Rankine, are deservedly associated with its development. I speak of this discovery as one of the present age because it has been established in our time; but

if we search back for earlier conceptions of the identity of heat and motion, we shall find (as we always do in such cases) that similar ideas have been held before, though in a clouded and undemonstrated form. In the writings of Lord Bacon we find it stated that heat is to be regarded as motion and nothing else. In dilating upon this subject, that extraordinary man shows that he had grasped the true theory of heat to the utmost extent that was compatible with the state of knowledge existing in his time. Even Aristotle seems to have entertained the idea that motion was to be considered as the foundation not only of heat, but of all manifestations of matter; and, for aught we know, still earlier thinkers may have held similar views.

The science of gunnery, to which I shall make but slight allusion on this occasion, is intimately connected with the dynamical theory of heat. When gunpowder is exploded in a cannon, the immediate effect of the affinities by which the materials of the powder are caused to enter into new combinations, is to liberate a force which first appears as heat, and then takes the form of mechanical power communicated in part to the shot and in part to the products of explosion which are also propelled from the gun. The mechanical force of the shot is reconverted into heat when the motion is arrested by striking an object, and this heat is divided between the shot and the object struck, in the proportion of the work done or damage inflicted upon each. These considerations recently led me, in conjunction with my friend Capt. Noble, to determine experimentally, by the heat elicited in the shot, the loss of effect due to its crushing when fired against iron plates. Joule's law, and the known velocity of the shot, enabled us to compute the number of dynamical units of heat representing the whole mechanical power of the projectile, and by ascertaining the number of units developed in it by impact, we arrived at the power which took effect upon the shot instead of the plate. These experiments showed an enormous absorption of power to be caused by the yielding nature of the materials of which projectiles are usually formed; but further experiments are required to complete the inquiry.

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Few sciences have more practical value than meteorology, and there are few of which we as yet know so little. Nothing would contribute more to the saving of life and property, and to augmenting the general wealth of the world, than the ability to foresee with certainty impending changes of the weather. At present our means of doing so are exceedingly imperfect, but, such as they are, they have been employed with considerable effect by Admiral FitzRoy in warning mariners of the probable approach of storms. We may hope that so good an object will be effected with more unvarying success when we attain a better knowledge of the causes by which wind and rain, heat and cold are determined. The balloon explorations conducted with so much intrepidity by Mr. Glaisher, under the auspices of the British Association, may perhaps in some degree assist in enlightening us upon these important subjects. We have learnt from Mr. Glaisher's observations that the decrease of temperature with elevation does not follow the law previously assumed of 1° in 300 feet, and that in fact it follows no definite law at all. Mr. Glaisher appears also to have ascertained the interesting fact that rain is only precipitated when cloud exists in a double layer. Rain-drops, he

has found, diminish in size with elevation, merging into wet mist, and ultimately into dry fog. Mr. Glaisher met with snow for a mile in thickness below rain, which is at variance with our preconceived ideas. He has also rendered good service by testing the efficiency of various instruments at heights which cannot be visited without personal danger.

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The science of organic life has of late years been making great and rapid strides, and it is gratifying to observe that researches both in zoology and botany are characterized in the present day by great accuracy and elaboration. Investigations patiently conducted upon true inductive principles cannot fail eventually to elicit the hidden laws which govern the animated world. Neither is there any lack of bold speculation contemporaneously with this painstaking spirit of inquiry. The remarkable work of Mr. Darwin promulgating the doctrine of natural selection has produced a profound sensation. The novelty of this ingenious theory, the eminence of its author, and his masterly treatment of the subject have perhaps combined to excite more enthusiasm in its favour than is consistent with that dispassionate spirit which it is so necessary to preserve in the pursuit of truth. Mr. Darwin's views have not passed unchallenged, and the arguments both for and against have been urged with great vigour by the supporters and opponents of the theory. Where good reasons can be shown on both sides of a question, the truth is generally to be found between the two extremes. In the present instance we may without difficulty suppose it to have been part of the great scheme of creation that natural selection should be permitted to determine variations amounting even to specific differences where those differences were matters of degree ; but when natural selection is adduced as a cause adequate to explain the production of a new organ not provided for in original creation, the hypothesis must appear, to common apprehensions, to be pushed beyond the limits of reasonable conjecture. The Darwinian theory, when fully enunciated, founds the pedigree of living nature upon the most elementary form of vitalized matter. One step further would carry us back, without greater violence to probability, to inorganic rudiments, and then we should be called upon to recognize in ourselves, and in the exquisite elaborations of the animal and vegetable kingdoms, the ultimate results of mere material forces left free to follow their own unguided tendencies. Surely our minds would in that case be more oppressed with a sense of the miraculous than they now are in attributing the wondrous things around us to the creative hand of a Great Presiding Intelligence.

The evidences bearing upon the antiquity of man have been recently produced in a collected and most logically-treated form by Sir Charles Lyell. It seems no longer possible to doubt that the human race has existed on the earth in a barbarian state for a period far exceeding the limit of historical record; but notwithstanding this great antiquity, the proofs still remain unaltered that man is the latest as well as the noblest work of God.

REPORT BY THE COMMITTEE APPOINTED TO INVESTIGATE SOME IMPROVEMENTS IN GUN-COTTON.

Since the invention of gun-cotton by Prof. Schönbein, the thoughts of many have been directed to its application to warlike purposes. Many trials and ex-

periments have been made, especially by the French; but such serious difficulties presented themselves that the idea seemed abandoned in every country but one, Austria. From time to time accounts reached England of its partial adoption in the Austrian service, though no explanation was afforded of the mode in which the difficulties had been overcome, or the extent to which the attempts had been successful. The Committe, however, had been put in possession of the fullest information from two sources—Prof. Abel, chemist to the War Department, and Baron W. von Lenk, Major-General in the Austrian Artillery, the inventor of the system. Prof. Abel, by permission of the authorities, communicated to the Committee the information given by the Austrian Government to our Government, and also the results of his own elaborate experiments. General von Lenk, on the invitation of the Committee, by permission of the Austrian Government, paid a visit to this country, to give every information in his power on the subject, and brought over drawings and samples from the Imperial factory. The following is a summary of the more important points:—As to the chemical nature of the material, Von Lenk's gun-cotton differs from the gun-cotton generally made, in its complete conversion into a uniform chemical compound. It is well known to chemists that, when cotton is treated with mixtures of strong nitric and sulphuric acids, compounds may be obtained varying considerably in composition, though they all contain elements of the nitric acid and are all explosive. The most complete combination (or product of substitution) is that described by M. Hadon as $C_{36} H_{21} (9\ NO_4)\ O_{30}$, which is identical with that termed by the Austrian chemists Trinitrocellulose, $C_{12}\ H_7\ (3\ NO_4)\ O_{10}$. This is of no use whatever for the making of collodion; but it is Von Lenks's gun-cotton, and he secures its production by several precautions, of which the most important are the cleansing and perfect desiccation of the cotton as a preliminary to its immersion in the acids,—the employment of the strongest acids attainable in commerce,—the steeping of the cotton in a fresh strong mixture of the acids after its first immersion and consequent imperfect conversion into gun-cotton,—the continuance of this steeping for forty-eight hours. Equally necessary is the thorough purification of the gun-cotton so produced from every trace of free acid. This is secured exclusively by its being washed in a stream of water for several weeks. These prolonged processes are absolutely necessary. It seems mainly from the want of these precautions that the French were not successful. From the evidence before the Committee it appears that this nitric compound, when thoroughly free from acid, is not liable to some of the objections which have been urged against that compound usually experimented upon as gun-cotton. It seems to have a marked advantage in stability over all other forms of gun-cotton that have been proposed. It has been kept unaltered for fifteen years; it does not become ignited till raised to a temperature of 136° C. (277° Fahr.); it is but slightly hygroscopic, and when exploded in a confined space, it is almost entirely free from ash. There is one part of the process not yet alluded to, and the value of which is more open to doubt—the treatment of the gun-cotton with a solution of silicate of potash commonly called water-glass. Prof. Abel and the Austrian chemists think lightly of it; but Von-Lenk considers that the amount of silica set free on the cotton by the carbonic acid of the atmosphere is really of service in retarding the combustion. He adds, that some of the gun-cotton made at the Imperial factory has not been silicated at all,

and some imperfectly; but when the process has been thoroughly performed, he finds that the gun-cotton has increased permanently about 3 per cent. in weight. Much apprehension has been felt about the effect of the gases produced by the explosion of the gun-cotton upon those exposed to its action. It has been stated that both nitrous fumes and prussic acid are among these gases, and that the one would corrode the gun and the other poison the artilleryman. Now, though it is true that from some kinds of gun-cotton, or by some methods of decomposition, one or both of these gases may be produced, the results of the explosion of the Austrian gun-cotton without access of air are found by Karolys to contain neither of them, but to consist of nitrogen, carbonic acid, carbonic oxide, water, and a little hydrogen and light carburetted hydrogen. These are comparatively innocuous; and it is distinctly in evidence that, practically, the gun is less injured by repeated charges of gun-cotton than of gunpowder, and that the men in casemates suffer less from its fumes. It seems a disadvantage of this material as compared with gunpowder that it explodes at a temperature of 277° Fahr.; but against the greater liability to accidents from this cause may be set the almost impossibility of explosion during the process of manufacture, since the gun-cotton is always immersed in liquid, except in the final drying.† Again, if it should be considered advisable at any time, it may be stored in water, and only dried in small quantities as required for use. The fact that gun-cotton is not injured by damp like gunpowder is, indeed, one of its recommendations, while a still more important chemical advantage which it possesses arises from its being perfectly resolved into gases on explosion; so that there is no smoke to obscure the sight of the soldier who is firing or to point out his position to the enemy, and no residuum left in the gun, to be got rid of before another charge can be introduced.

As regards the mechanical portion of this question, it appears that greater effects are produced by gases generated from gun-cotton than by gases generated from gunpowder, and it was only after long and careful examination that the Committee were able to reconcile this fact with the low temperature at which the mechanical force is obtained. The great waste of force in gunpowder constitutes an important difference between it and gun-cotton, in which there is no waste. The waste in gunpowder is 68 per cent. of its own weight, and only 32 per cent. is useful. This 68 per cent is not only waste in itself, but it wastes the power of the remaining 32 per cent. It wastes it mechanically, by using up a large portion of the mechanical force of the useful gases. The waste of gunpowder issues from the gun with much higher velocity than the projectile; and if it be remembered that in 100 lb. of useful gunpowder this is 68 lb., it will appear that 32 lb. of useful gunpowder gas is wasted in impelling a 68-lb. shot composed of the refuse of gunpowder itself. There is yet another peculiar feature of gun-cotton. It can be exploded in any quantity instantaneously. This was once considered its great fault; but it was only a fault when we were ignorant of the means to make that velocity anything we pleased. General von Lenk has discovered the means of giving gun-cotton any velocity of

† In ten years' experience it is proved that this temperature is sufficiently high to insure safety of manipulation; 277° Fahr. is an artificial temperature, and artificial temperatures accidentally produced are generally high enough to ignite gunpowder. The greater liability to accident from this cause can, therefore, scarcely be admitted.

explosion that is required for merely the mechanical arrangements under which it is used. Gun-cotton in his hands has any speed of explosion, from 1 foot per second to 1 foot in $\frac{1}{1000}$ of a second, or to instantaneity. The instantaneous explosion of a large quantity of gun-cotton is made use of when it is required to produce destructive effects on the surrounding material. The slow combustion is made use of when it is required to produce manageable power, as in the case of gunnery. It is plain, therefore, that, if we can explode a large mass instantaneously, we get out of the gases so exploded the greatest possible power, because all the gas is generated before motion commences, and this is the condition of maximum effect. It is found that the condition necessary to produce instantaneous and complete explosion is the absolute perfection of closeness of the chamber containing the gun-cotton. The reason of it is, that the first ignited gases must penetrate the whole mass of the cotton, and this they do, and create complete ignition throughout, only under pressure. This presure need not be great. For example, a barrel of gun-cotton will produce little effect and very slow combustion when out of the barrel, but instantaneous and powerful explosion when shut up within it. On the other hand, if we desire gun-cotton to produce mechanical work, and not destruction of materials, we must provide for its slower combustion. It must be distributed and opened out mechanically, so as to occupy a larger space, and in this state it can be made to act even more slowly than gunpowder; and the exact limit for purposes of artillery General von Lenk has found by critical experiment. In general, it is found that the proportion of 11 lb. of gun-cotton, occupying 1 cubic foot of space, produces a greater force than gunpowder, of which from 50 to 60 lb. occupies the same space, and a force of the nature required for ordinary artillery. But each gun and each kind of projectile requires a certain density of cartridge. Practically, gun-cotton is most effective in guns when used as $\frac{1}{4}$ to $\frac{1}{3}$ weight of powder, and occupying a space of $1\frac{1}{10}$ of the length of the powder cartridge. The mechanical structure of the cartridge is of importance as affecting its ignition. The cartridge is formed of a mechanical arrangement of spun cords, and the distribution of these, the place and manner of ignition, the form and proportion of the cartridge, all affect the time of complete ignition. It is by the complete mastery he has gained over all these minute points that General von Lenk is enabled to give to the action of gun-cotton on the projectile any law of force he pleases. Its cost of production is considerably less than that of gunpowder, the price of quantities which will produce equal effects being compared. Gun-cotton is used for artillery in the form of a gun-cotton thread or spun yarn. In this simple form it will conduct combustion slowly in the open air, at a rate of not more than 1 foot per second. This thread is woven into a texture or circular web. These webs are made of various diameters, and it is out of these webs that common rifle cartridges are made, merely by cutting them into the proper lengths, and inclosing them in stiff cylinders of pasteboard, which form the cartridges. (In this shape its combustion in the open air takes place at a speed of 10 feet per second.) In these cylindrical webs it is also used to fill explosive shells, as it can be conveniently employed in this shape to pass in through the neck of the shell. Gun-cotton thread is spun into ropes in the usual way up to 2 inches diameter, hollow in the centre. This is the form used for blasting and mining purposes; it combines great density with

speedy explosion. The gun-cotton yarn is used directly to form cartridges for large guns by being wound round a bobbin so as to form a spindle like that used in spinning-mills. The bobbin is a hollow tube of paper or wood, the object of the wooden rod is to secure in all cases the necessary length of chamber in the gun required for the most effective explosion. The gun-cotton circular web is inclosed in close tubes of india-rubber cloth to form a match line, in which form it is most convenient and travels with speed and certainty. In large quantities, for the explosion of mines, it is used in the form of rope, and in this form it is conveniently coiled in casks and stowed in boxes. As regards conveyance and storage of gun-cotton: it results from the foregoing facts, that 1 lb. of gun-cotton produces an effect exceeding 3 lb. of gunpowder in artillery. This is a material advantage whether it be carried by men, by horses, or in waggons. It may be placed in store, and preserved with great safety. The danger from explosion does not arise until it is confined. It may become damp and even perfectly wet without injury, and may be dried by mere exposure to the air. This is of great value in ships of war, and in case of danger from fire, the magazine may be submerged without injury. As regards its practical use in artillery, it is easy to gather from the foregoing general facts how gun-cotton keeps the gun clean and requires less windage, and therefore performs much better in continuous firing. In gunpowder there is 68 per cent. of refuse, or the matter of fouling. In gun-cotton there is no residuum, and therefore no fouling. Experiments made by the Austrian Committee proved that 100 rounds could be fired with gun-cotton, against 30 rounds of gunpowder. From the low temperature produced by gun-cotton the gun does not heat. Experiments showed that 100 rounds were fired with a 6-pounder in 36 minutes, and the gun was raised by gun-cotton to only 122° Fahrenheit, whilst 100 rounds with gunpowder took 100 minutes, and raised the temperature to such a degree that water was instantly evaporated. The firing with the gunpowder was, therefore, discontinued; but the rapid firing with the gun-cotton was continued up to 180 rounds without any inconvenience. The absence of fouling allows all the mechanism of a gun to have much more exactness than where allowance is made for fouling. The absence of smoke promotes rapid firing and exact aim. There are no poisonous gases, and the men suffer less inconvenience from firing in casemates, under hatches, or in closed chambers. The fact of smaller recoil from a gun charged with gun-cotton is established by direct experiment: its value is $\frac{2}{3}$ of the recoil from gun-powder, projectile effect being equal. To understand this may not be easy The waste of the solids of gunpowder accounts for one part of the saving, as in 100 lb. of gunpowder 68 lb. have to be projected in addition to the shot, and at a much higher speed. The remainder, General von Lenk attributes to the different law of combustion. But the fact is established. The comparative advantages of gun-cotton and gunpowder for producing high velocities, are shewn in the following experiment with a Krupp's cast-steel gun, 6-pounder. With ordinary charge 30 oz. of powder produced 1,338 feet per second. With charge of 13½ oz., gun-cotton produced 1,563 feet. The comparative advantages in shortness of gun are shown in the following experiments, 12-pounder:—

	Calibres.	Charge.	Velocity, feet per second.
Cotton, length,	10	15·9 oz.	1,426
Powder, "	13½	49 (normal powder charge.)	1,400
Cotton, "	9	17	1,402

—As to advantage in weight of gun, the fact of the recoil being less in the ratio of 2 : 3 enables a less weight of gun to be employed, as well as a shorter gun, without the disadvantage to practice arising from lightness of gun. As regards durance of gun, bronze and cast-iron guns have been fired 1,000 rounds without in the least affecting the endurance of the gun. As regards its practical application to destructive explosions of shells, it appears that from a difference in the law of expansion, arising probably from the pressure of water in intensely-heated steam, there is an extraordinary difference of result, namely, that the same shell is exploded by the same volume of gas into more than double the number of pieces. This is to be accounted for by the greater velocity of explosion when the gun-cotton is confined very closely in very small spaces. It is also a peculiarity that the stronger the shell the smaller the fragments into which it is broken. As regards mining uses, the fact that the action of gun-cotton is violent and rapid in exact proportion to the resistance it encounters, tells us the secret of its far higher efficiency in mining than gunpowder. The stronger the rock, the less gun-cotton, comparatively with powder, is neeessary for the effect; so much so that while gun-cotton is stronger than powder as 3 to 1 in artillery, it is stronger in the proportion of 6·274 to 1 in a strong and solid rock, weight for weight. It is the hollow rope form which it is used for blasting. Its power of splitting up the material is regulated exactly as wished. As regards military and submarine explosion, it is a well-known fact, that a bag of gunpowder nailed on the gates of a city will blow them open. In this case gun-cotton would fail. A bag of gun-cotton exploded in the same way is powerless. If one ounce of gunpowder is exploded in scales, the balance is thrown down; with an equal force of gun-cotton nothing happens. To blow up the gate of a city a very few pounds of gun cotton, carried in the hand of a single man, will be sufficient, only he must know its nature. In a bag it is harmless; exploded in a box it will shatter the gates to atoms. Against the palisades of a fortification: a small square box containing 25 lb., merely flung down close to it will open a passage for troops; in actual experience on palisades a foot diameter and 8 feet high, piled in the gronnd, backed by a second row of 8 inches diameter, a box of 25 lb. cut a clean opening 9 feet wide. To this three times the weight of gunpowder produced no effect whatever, except to blacken the piles. Against bridges: a strong bridge of oak, 24 feet span, was shattered to atoms by a small box of 25 lb. laid on its centre; the bridge was not broken, it was shivered. As to its effect under water: in the case of two tiers of piles, in water 13 feet deep, 10 inches apart, with stones between them, a barrel of 100 lb. gun-cotton, placed 3 feet from the face and 8 feet nnder water, made a clean sweep through a radius of 15 feet, and raised the water 200 feet. In Venice a barrel of 400 lb. placed near a sloop in 10 feet water, at 18 feet distance, threw it in atoms to a height of 400 feet. All experiments made by the Austrian Artillery Committee were conducted on a grand scale,—36 batteries, six and twelve pounders (gun cotton) having been constructed, and practised with that material.

The reports of the Austrian Commissioners are all based on trials with ordnance, from six pounders to forty-eight pounders, smooth bore and rifled cannon. The trails with small fire arms have been comparatively few, and not reported on. The trials for blasting and mining purposes were also made on a large scale by the Imperial Engineers' Committee, and several reports have been printed on the subject.

Sir W. Armstrong said it was impossible to listen to the report which had been read without being very much impressed with the great promise there was of gun-cotton becoming a substitute for gunpowder ; but at the same time there were certain peculiar anomalies about it which he certainly should like to have cleared up, and until they were, they could not feel that perfect confidence in the results that they wished to do. In the first place, with regard to the heat evolved, they were told that, with such a quantity of gun cotton as would produce a given quantity of gas, a certain initial velocity was imparted to the projectile, and that the heating effect upon the gun was much less than when a similar velocity was produced by an equivalent quantity of gunpowder. The absence of heat in the gun implied an absence of heat in the gas. Where was the projectile force to come from, if there was no heat in the gas? He could not, for his part, conceive how it was possible of explanation. The next point that occurred to him was with regard to the recoil. It was stated that the recoil was very much less. That was ascribed to the absence of solid inert matter in the charge, which, in gun-cotton, was next to nothing. If the recoil was only two-thirds that of gunpowder, it would require, in order to account for that difference, a much larger quantity of solid matter than there really was in the case of gunpowder. The report stated that the use of gun-cotton enabled them to reduce the length of the gun. It was quite certain, however, that with a short gun they could not get an equal initial velocity as with a long gun. If the initial velocity were increased there was more danger of bursting the gun than with gunpowder. Because if they got any velocity, or an equal velocity with the shorter gun, it must be concluded that it was done by virtue of a greater initial pressure and an earlier action upon the shot. That necessarily implied a greater strain upon the gun at the first explosion, and that would necessitate the employment of stronger guns. He should have expected a smaller velocity by a shorter gun, for the action of the gas was necessarily shorter than in a longer gun. The heat question, however, was to him the greatest puzzle of all. How they could have the propelling power without heat in the gas, and if they heated the gas, how they escaped heating the gun, he could not understand.—Prof. Pole said he was quite unable to give any explanation of the difference of recoil. If the shot left the gun with the same velocity as when fired with gunpowder, it was natural to suppose that there must be the same quantity of recoil.—Mr. Siemens having briefly spoken on the dynamical question involved in the matter, suggested that the greater heat imparted to the gun in the case of gunpowder might be owing to the greater amount of solid matter, which taking up the great heat of the gases under a pressure of some 400 atmospheres imparted a portion of the same by radiation to the side of the gun, while in the case of gun-cotton gases only were produced, which could only impart heat to the gun by the slower process of conduction, and left a larger margin of heat to be developed in force by expansion.—Admiral Sir

E. Belcher thought that the reason the gun was not heated by an explosion of gun-cotton might be because the gases had not time to heat the gun owing to the rapidity of the explosion, which was slower in the case of gunpowder; or that it might arise from the greater amount of fouling in the case of gunpowder.—Capt. Maury said this Report was something more than interesting, because it was so exceedingly suggestive; and it appeared to him that it afforded them an element of security by giving the preponderance on the side of defence. Ever since steam had been applied to purposes of naval warfare it had been considered a matter of very great doubt by many professional men how far ordinary steamers and men-of-war, where forts were to be passed at the mouth of a river, were capable of sustaining the fire of such forts and passing up the river. And to show that there was ample time for them to do so, they had only to recollect the fact of steamers having fought forts for several hours. In the Crimea and at Charleston the steamers had remained under fire for several hours—a much longer time than was necessary to enable them to pass the forts and go higher up the river into a place of safety where they could do damage to the enemy. Iron clads had rendered this much more easy than it had previously been. If then their principal defences failed them at the mouth of the river in this way, the question was whether they should not have recourse to mining for the destruction of the invading vessels? He himself had been engaged upon the subject. He found this difficulty in employing gunpowder, that in order to be sure of destroying the vessel as she passed in a given line by means of gunpowder, the magazines must be in actual contact, or very nearly in actual contact with the side of the vessel; otherwise the probability was that the vessel would not be destroyed. Last week they had the intelligence of a vessel having had a mine exploded under her on the James River. That magazine contained several thousands of pounds of powder. The vessel did not know that the mine was there; but the mine did not destroy the vessel. It merely threw up a column of water which washed some of the men overboard. His own conclusion was that to make sure of destroying a vessel after she had passed the forts, they must mine the channel in such a manner that the vessel must come in contact with one or other of the mines. It was found that wooden vessels to contain the powder would not do. They would not confine the powder long enough to produce a sufficient foree. It was necessary to make them of stout boiler iron. It would not do to leave the magazines on the top of the water, and it would not do to put them at the bottom, for then there would be a cushion of water between the bottom of the ship to be destroyed and the magazine, which would protect the vessel. In short they had to anchor them beneath the surface with short buoy-ropes, at a depth proportioned to the kind of vessel expected to come up. But when they made the magazine of boiler-iron they had to have buoys to float it so large that they were always in danger of being carried away by the vessels crossing the line of magazine. The plan was to place those magazines in a ring in such a position that the vessel in passing would have to come in contact with at least one and probably two of them. It was necessary to place those magazines of powder so that when you saw the vessel in that range you had only to bring the two poles of the galvanic battery together and make the explosion. There was, as already stated, a difficulty in using gunpowder. But since gun-cotton had the remarkable effect of destroying a vessel—he did not

know her strength—at a distance of 18 feet, and that not vertically, but laterally, the question arose whether they might not fortify and protect those channel ways by placing a ring of gun cotton magazines along the bottom; but, at any rate, if that was not necessary, they could float them at any depth, and out of reach of the vessels generally using the channel. That appeared to him to be one of the most important uses of gun cotton, and it was one which would give safety to cities which were some distance from the mouths of navigable rivers. He trusted that in the event of the Committee continuing their labours, they would address their attention to this important point.—Admiral Sir E. BELCHER stated that the explosion of powder under water was once done under one of his own vessels to clear away ice. He placed it upon the ground, thinking that its explosion would blow the ice clear of her bows without touching the vessel. There was, however, sufficient water to form a cushion, and when the explosion took place it only produced a great wave upon which the vessel rose. Prof. POLE said what they wanted was something to show the varying pressure of the gases in the gun; in fact, an indicator diagram.—Mr. J. SCOTT RUSSELL set himself to clear away the many difficulties which attended this very difficult subject. How was it that in gunpowder and in gun-cotton where there were equal quantities of gas put in, the gas in the case of gunpowder was raised to an enormously high temperature, and came out at an enormously high pressure, showing that they had gas enormously expanded by heat; whereas in the case of gun-cotton the gas came out quite cool, so that you might put your hand upon it, and the gun itself was quite cool? He (Mr. Russell) had a theory. Steam was a gas, and steam expanded just by the same laws as other gases did. A great deal of the gas of gun-cotton happened to be steam. Let them conceive 100 lb. of gun-cotton shut up in a chamber that just held it. They had got there all the gases that had been spoken of, but they had also got 25 lb. of solid water—about one-third of a cubic foot of water—in that chamber. What did they do with it? They put fuel, they put fire to it. They heated the whole remaining pounds of patent fuel. If, then, they considered the gun-cotton gun as the steam-gun, they got rid of two difficulties. They would have, first, the enormous elasticity of steam; and secondly, they would get the coolness of it. They all knew that if they put their hand to expanded high pressure steam, it had swallowed up all the heat and came out quite cool. He believed that the gun-cotton gun was neither more nor less than Perkins's old steam gun with only this difference, that you bottled up the fuel and water, and let them fight it out with each other. They did their work and came out quite cool. He hoped, however, that it was understood that he did not dogmatize. He put all he had said with a note of interrogation upon it. Prof. TYNDALL said he thought that a note of interrogation ought to be put to what Mr. Russel had said.

The subject is considered of so much importance that the British Association, though it has re-appointed the Joint-Committe to continue its inquiries, has passed a resolution to urge on the Government the appointment of a Commission by means of which a more complete investigation, and such as the subject unquestionably deserves, may be made than the means at the disposal of the Association will admit of.

A communication from the Astronomer Royal, 'On Boiler Explosions,' was read by Mr. P. Le Neve Foster. The author stated that, in considering the cause of the extensive mischief done by the bursting of a high-pressure boiler, it is evident that the small quantity of steam contained in the steam chamber has very little to do with it. That steam may immediately produce the rupture, but as soon as the rupture is made, and some steam escapes, and the pressure on the water is diminished, a portion of the water is immediately converted into steam at a slightly lower temperature and lower pressure, and this, in the same way, is followed by other steam at still lower temperature and pressure, and so on till the temperature is reduced to 212° Fahr. and the pressure to 0. Then there remains in the boiler a portion of water at the boiling point, the other portion having gone off in the shape of steam of continually diminishing pressure. From this it is evident that the destructive energy of the steam, when a certain pressure is shown by the steam gauge, is proportional to the quantity of water in the boiler. By the assistance of Prof. Miller, of Cambridge, Messrs. Ransome, of Ipswich, and George Biddell, Esq., the author has been able to obtain a result which he believes to be worthy of confidence. He first stated, as the immediate result of Mr. Biddell's experiments, that when there were in the boiler of a small locomotive 22 cubic feet of water, at the pressure of 60 lb. per square inch, and the fire was raked out, and the steam was allowed gently to escape, with perfect security against priming, the quantity of water which passed off before the pressure was reduced to 0 was $2\frac{3}{4}$ cubic feet, or $\frac{1}{8}$ of the whole. In regard to the use made of Prof. Miller's theory, Prof. Miller had succeeded in obtaining a numerical expression for the pressure of steam at twelve different measures of the volume occupied by water and steam, which expression the author has succeeded in integrating accurately, and had thus obtained an accurate numerical expression for the destructive energy of steam. In regard to the use of General Didion's experiments, these experiments gave the velocity of the ball, in cannon of different sizes, produced by different charges of powder. The author found, by trial with the formula $\frac{Wv^2}{2g \times \text{weight of powder}}$, which of these experiments exhibits the greatest energy per kilogramme of powder, and had adopted it in the comparison. The result is as follows:—the destructive energy of one cubic foot of water, at 60 lb. pressure per square inch is equal to the destructive energy of two English pounds of gunpowder in General Didion's cannon experiments; Gen. Didion's experiments were made as the author understood with smooth bored cannon. It cannot be doubted that much energy is lost in the windage; some also from the circumstance that the propelling power ceases at the muzzle of the gun, before all the energy is expended; and some from the coolness of the metal. If we suppose that from all causes one-half of the energy is lost, then we have this simple result: the gauge-pressure being 60 lb. per square inch, 1 cubic foot of water is as destructive as 1 lb. of gunpowder. In one of Mr. Biddell's experiments, the steam-valve was opened rather suddenly, and the steam escaped instantly with a report like that of a very heavy piece of ordnance. This is not to be wondered at; it appears from the comparison above that the effect was the same as that of firing a cannon whose charge is 44 lb. of powder.

'On Spectral Analysis,' by Prof. Plucker.—It is generally admitted now, that every gaseous body rendered luminous by heat or electricity sends out a peculiar

light, which, if examined by the prism, gives a well-defined and characteristic spectrum. By such a spectrum, by any one of its brilliant lines, whose position has been measured, you may recognize the examined gas. This way of proceeding constitutes what is called spectral analysis, to which we owe, until this day, the discovery of three new elementary bodies. In order to give to spectral analysis a true and certain basis, you want the spectrum of each elementary substance. Most recently, some eminent philosophers, in examining such spectra, met with unexpected difficulties, and doubts arose in their minds against the new doctrine. These doubts are unfounded. The fact is, that the molecular constitution of gases is much more complicated than it has been generally admitted till now. The spectra, therefore, always indicating the molecular constitution of gases, ought to be more complicated also than it was thought at first. By these considerations, a new importance a rather physical one, is given to spectral analysis. You may recognize by the spectrum of a gas, not only the chemical nature of the gas, but you may also obtain indications of its more intimate molecular structure—quite a new branch of science. Allow me now to select out of the results already obtained two instances only. Let me try to give what I may call the history of the spectra of two elementary bodies—of sulphur and nitrogen. In order to analyse by the prism the beautiful light produced by the electric current, if it pass through a rarefied gas, I gave to the tube in which the gas is included such a form that its middle part was capillary. Thus I got within this part of the tube a brilliant film of light, extremely fitted to be examined by the prism. The date of my first paper on this subject is the 12th of March. 1858. After having provided myself with apparatus more suited to my purposes, I asked, about a year ago, my friend, Prof. Hittorf, of Münster, to join me in taking up my former researches. The very first results we obtained in operating on gases of a greater density opened to us an immense field of new investigation. We found that the very same elementary substance may have two, even three, absolutely different spectra, which only depend on temperature. In our experiments we made use of Ruhmkorff's induction coil, whose discharge was sent through our spectral tubes. In order to increase at other times the heating power of the discharge, we made use of a Leyden jar. Now, let us suppose a spectral tube, most highly exhausted by Geissler's mercury pump, contains a very small quantity of sulphur. The discharge of the coil will not pass through the tube if it do not meet with ponderable matter, either taken from the surface of the glass, or, if the discharge be very strong, by the chemical decomposition of the glass. In heating slowly the tube by means of a lamp, in order to transform a part of the sulphur into vapour, all accidental spectrum, if there be one, will disappear, and you will get a pure and beautiful spectrum of sulphur. I supposed the Leyden jar not to have been interposed. If you now interpose it, the spectrum just spoken of will suddenly be replaced by a quite different one. We were generally led to distinguish two quite different classes of spectra. Spectra of the first class consist in a certain number of bands, variously shadowed by dark transversal lines. Spectra of the second class consist in a great number of most brilliant lines on a dark ground. Accordingly, sulphur has one spectrum of the first class and another one of the second class. You may as often as you like obtain each of these two spectra. In operating on a spectral tube, containing nitrogen at a tension of about 50 millimètres, you will, without the Leyden jar, get

a most beautiful spectrum of the first class. After interposing the jar, a splendid spectrum of the second class will be seen. But here the case is more complicated yet. The above mentioned spectrum of the first class is not a simple one, but it is produced by the superposition of two spectra of the same class. Ignited nitrogen at the lowest temperature has a most beautiful colour of gold. When its temperature rises, its colour suddenly changes into blue. In the first case, the corresponding spectrum is formed by the less refracted bands extended towards the violet part; in the second case, it is formed by the more refracted band of the painting extending towards the red. Nitrogen, therefore, has two spectra of the first class and one spectrum of the second class. The final conclusion, therefore, is that sulphur has two, nitrogen three, different allotropic states. It may appear very strange that a gaseous body may have different allotropic states—*i. e.*, different states of molecular equilibrium. It may not appear, perhaps, more strange that a substance, hitherto supposed to be an elementary one, may really be decomposed at an extremely high temperature. From spectral analysis there cannot be taken any objection that sulphur and nitrogen may be decomposed. Chloride of zinc (or cadmium), for instance, exhibits two different spectra. If heated like sulphur and then ignited by the discharge of Ruhmkorff's coil, you will get a beautiful spectrum either of chlorine or of the metal, if either the Leyden jar be not interposed or be interposed. There is, in this case, a dissociation of the elements of the composed body in the highest temperature, and re-composition again at the lower temperature. You may consider the dissociation as an allotropic state, and, therefore, I may make use of this term as long as the decomposition be not proved by the separated elements.

'On the Star Chromatoscope,' by Mr. A. Claudet.—The scintillation and change of colours observed in looking at the stars are so rapid that it is very difficult to judge of the separate lengths of their duration. If we could increase on the retina the length of the sensations they produce we should have the better means of examining them. This can be done by taking advantage of the power by which the retina can retain the sensation of light during a fraction of time which has been found to be one-third of a second—a phenomenon which is exemplified by the curious experiment of a piece of incandescent charcoal revolving round a centre, and forming a continual circle of light. It is obvious that if the incandescent charcoal during its revolution was evolving successively various rays, we could measure the length and duration of every ray by the angle each would subtend during its course. This is precisely what can be done with the light of the star. It can indeed be made to revolve like the incandescent charcoal, and form a complete circle on the retina. When we look at a star with a telescope we see it on a definite part of the field of the glass; but if with one hand we slightly move the telescope the image of the star changes its position, and during that motion, on account of the persistence of sensation on the retina, instead of appearing like a spot, it assumes the shape of a continued line. Now if, instead of moving the telescope in a straight line, we endeavour to move it in a circular direction, the star appears like a circle, but very irregular, on account of the unsteadiness of the movement communicated by the hand. Such is the principle of the instrument employed by the author to communicate the perfect circular motion which it is impossible to impart by the hand. The instrument consists of a conical tube

placed horizontally on a stand, and revolving on its own axis by means of wheels inside this tube a telescope or an opera glass is placed, by which, by means of two opposite screws, the end of the object-glass can be placed in an excentric position in various degrees according to the effect desired, while the eye-glass remains in the centre of the small end of the tube. Now, if we understand that when the machine makes the tube to revolve upon its axis, the telescope inside revolves in an excentric direction, during the revolution the star seen through it must appear like a circle. This circle exhibits on its periphery the various rays emitted by the star, all following each other in spaces corresponding with their duration, showing also blank spaces between two contiguous rays which must correspond with the black lines of the spectrum. The instrument, in fact, is a kind of spectroscope, by which we can analyze the light of any star, study the cause of the scintillation, and compare its intensity in various climates or seasons and at different altitudes.

The Abbe Moigno exhibited and described M. Soleil's Tenebroscope, for illustrating the invisibility of light. . It is well known to scientific men, although the general public do not sufficiently appreciate the fact, that light in itself is invisible unless the eye be so placed as to receive the rays as they approach it, or unless some object be placed in its course, from whose surface the light may be reflected to the eye, which will generally thus give notice of the presence of that object. Thus, if the strong beam of sunlight be admitted into a darkened chamber through a small opening and received on some blackened surface placed against the opposite wall, the entire chamber will remain in perfect darkness, and all the objects in it invisible, except in as far as small motes floating in the air mark the course of the sunbeam by reflecting portions of its light. Upon projecting a fluid or small dust across the course of the beam its presence also becomes perceptible. The instrument exhibited consisted of a tube with an opening at one end to be looked into, the other end closed, the inside well blackened, and a wide opening across the tube to admit strong light to pass only across. On looking in all is perfectly dark, but a small trigger raises at pleasure a small ivory ball into the course of the rays, and its presence instantly reveals the existence of the crossing beam by reflecting a portion of its light.

'On the System of Forecasting the Weather pursued in Holland,' by Dr. Buys Ballot.—The author said:—"I shall not abuse your indulgence, which I earnestly implore. I shall very shortly explain (1.) what are the rules about foretelling weather in Holland, given before a similar system was introduced in England; (2.) how they behaved themselves; and (3.) what is to be done now: and I will very abundantly answer to any question or remark if they be made, for in that case I am justified in trespassing on your time.—(1.) Under our plan, where observations are taken in Holland, there are four principal places: Helder indicated by H, Groningen indicated by G, Flushing indicated by V, and Maestricht indicated by M, on the indications of which I base my forecasts, and in the first place on the barometer readings. For every day of the year and for every hour of the day I have very carefully determined the height of the barometer in the place of observation at that height above the sea, where it is suspended. This is a cardinal point not sufficiently observed in England, and not at all in France. The differ-

ence of an observed pressure from that calculated on I call the departure of the pressure—positive when the pressure is greater, negative when it is less. Those departures, besides the observations of the other instruments, are communicated from post to post. The rule is now very simple. If the departures are greater (more positive) in the southern places than in the northern, greater at M. or V. than at G. or H., the wind will have a W. in its name; when the departures are greater in the northern places the wind will have an E. in its name. More accurately, you may say, the wind will be nearly at right angles with the direction of the greatest difference of pressures. When you place yourself in the direction of the wind (or in the direction of the electric current) you will have at your left the least atmospheric pressure (or the north pole of the magnet). When the difference of pressure of the southern places above the northern is not above four millimètres there will be no wind of a force above 30 lb. on the square mètre. Moreover, the greatest amount of rain will fall when the departures are negative; and at the places where the departures are most negative, there also the force of the wind will be generally stronger. Moreover, there will be no thunder if the barometric pressure is not less than two millimètres above the average height, and when at the same time the difference of the departures of temperature is considerable. Those rules, and especially the first two, were laid down by me, in 1857, in the *Comptes Rendus*, and on the 1st of June, 1860, the first telegraphic warning by order of the Department of the Interior was given in Holland. It was unfortunate that those telegraphic warnings were not introduced four days sooner, for in that case the first communication would have been a first warning against the fearful storm of May 28, 1860, called the Finster-storm. All of you know how amply Admiral Fitz Roy has arranged the telegraph warnings all over England. —2. Those rules used in Holland have behaved themselves very well, as is laid down in the translation of a paper of Mr. Klein, captain of a merchant ship, whereto I have added my observations and signals compared with the signals of Admiral Fitz Roy in table A, p. 25. My own paper dates from June 1, 1860, and is extracted by Mr. Klein as you may see, but I preferred that the less complete and precise paper of a practical man be translated, because I thought that the seamen would put more reliance on it. From the tables added to that translation it appears that I have warned from my four stations, just as Admiral Fitz Roy has done from his twenty. It must, however, be recorded that besides those four stations, there are also some stations—Paris, Havre, Brest—in France, and some in England—Hartlepool, Yarmouth, Portsmouth, Plymouth—that send me their observations. Generally they arrive too late, and therefore they throw but very little light on the forecasting, principally while the barometers are not so well known. So much for the strength, now for the direction. The direction is in the first twenty-four hours after the observations three times of the four such as indicated, and the second 24 hours and the third 24 hours still two times of the three such as indicated (see table B, p. 29), and moreover no storm has occurred in those six years when not before the difference of the southern departures above the northern has been four millimètres.—To come to the third point. 3rd. What is to be done? The normal heights of the barometric pressure, or better, of the barometers, which are read, must be conscientiously taken, the observation must be made at more points once a day, and mutually communicated, and at days when

there are greatly different departures, that is to say, of three millimètres, or when there is change of inclination, there must be sent a message at noon or in the evening of the same day. In all cases, not only the pressure in the morning, but likewise that at night should be given. A critical indication is, when the previous day the northern stations had greater departures, and the following day the southern had greater departures, even when the difference in the latter case was small. There is caution to be had when the difference of the departures is 4 millimètres. But I may not trespass on your time and kindness in expressing wishes only, it may be sufficient to have communicated the general rule.

'On Aluminium,' by Mr. I. L. Bell.—The author said—"The progress of the manufacture of this, so far as the arts are concerned, new metal has scarcely been such as to require much to be added to the researches bestowed upon the process by the distinguished chemist, M. St. Cairi Deville, of Paris. Upon the introduction of its manufacture at Washington, three years and a half ago, the source of the alumina was the ordinary ammonia alum of commerce, a nearly pure sulphate of alumina and ammonia. Exposure to heat drove off the water, sulphuric acid and ammonia, leaving the alumina. This was converted into the donble chloride of aluminium and sodium by the process described by the French chemist and practised in France, and the double chloride subsequently decomposed by fusion with sodium. Faint, however, as the traces might be of impurity in the alum itself, they, to a great extent, if not entirely, being of a fixed character when exposed to heat, were to be found in the alumina, from which, by the action of the chlorine on the heated mass, a large proportion, if not all, found their way into the sublimed double chloride, and once there, it is unnecessary to say that under the influence of the sodinm, any silica, iron, or phosphorus found their way into the aluminium sought to be obtained. Now, it happens that the presence of these impurities in a degree so small as almost to be infinitesimal, interferes so largely with the colour as well as with the malleability of the aluminium that the use of any substance containing them is of a fatal character. Nor is this all, for the nature of that compound which hitherto has constituted the most important application to this metal—I mean aluminium-bronze—is so completely changed by using aluminium containing the impurities referred to, that it ceases to possess any of those properties which render it valuable. As an example of the amount of interference exercised by very minute quantities of foreign matters, it is, perhaps, worthy of notice that very few varieties of copper have been found susceptible of being employed for the manufacture of aluminium-bronze; and hitherto we have not at Washington, nor have they in France, been able to establish in what the difference consists between copper fit for the production of aluminium-bronze, and that which is utterly unsuitable for the purpose. These consideratious have led us, both here and in France, to adopt the use of another raw material for the production of aluminium, which either does not contain the impurities referred to as so prejudicial, or contains them in such a form as to admit of their easy separation. This material is Bauxite, so called from the name of the locality where it is found in France. The Bauxite is ground and mixed with tke ordinary alkali of commerce, heated in a furnace. The metal is so extensively used in the arts as to keep the only work in England, namely, that at Washington, pretty actively employed. As a substance for works of art, when whitened by means of hydro-

fluoric and phosphoric acid, it appears well adapted, as it runs into the most complicated patterns, and has the advantage of preserving its colour, from the absence of all tendency to unite with sulphur or become affected by sulphuretted hydrogen. A large amount of the increased activity in the manufacture referred to is due to the exceeding beauty of its compound with copper, which is so like gold as scarcely to be distinguishable from that metal, with the additional valuable property of being nearly as hard as iron."

'On the Syndactylous Condition of the Hand in Man and the Anthropoid Apes,' by Mr. C. C. Blake.—The author said, "I call the attention of the Section to a curious abnormity which is presented by the integument of a specimen of old male gorilla which was brought from the Gaboon by Mr. W. Winwood Reade, and presented by that gentleman to the Museum of the Anthropological Society of London. The specimens of gorilla which have been the subjects of the elaborate and complete Memoirs which have appeared from the pens of MM. Duvemoz and Isidore Geoffroy St. Hilaire, in the Archives of the Paris Museum (vols. viii. and x.) and by Prof. Owen in various parts of the Zoological *Transactions*, have, with other authors, all coincided in the statement of a fact, true as regards the specimens with which they were acquainted, which probably represent the majority of specimens of gorilla which have been examined in Europe. This statement, reduced to a general proposition, was that the integument of the skin of the fingers was more or less connected across the first digital phalanx in such a manner that the first joints were firmly connected together by skin, sometimes as far as the distal extremity of the first phalanx, sometimes merely to the middle of this phalanx. In no specimen of gorilla, of the description of which I am yet cognizant, are the digits of the anterior extremity free to the same extent as in man, in which the distal extremities of the metacarpals mark the termination of the amount of syndactylity of the hand. In the specimen of gorilla to which allusion is made in this short note, the digits of the fingers present a different condition of connection from the typical specimens described by zoologists. The second (index), third (medius), and fourth (annulus) digits are free beyond the distal end of the metacarpals as in the human subject; the fifth digit (minimus) is also in a less degree attached to the annulus than in the specimens of gorilla contained in various public museums. We have thus a specimen of gorilla in which the digits of the hand are almost as free as in the hand of the lower races of mankind. Careful examination by a lens of the integument before the preparation of the specimen by Mr. Leadbeater, who first called my attention to this abnormity, demonstrates the fact that the epidermis covers the cutis on the inner sides of the interdigital spaces of the first phalanges of this specimen. The consistency of this epidermis merely differs in degree from that of the homologous structure in the foot and other parts of the body. It would be interesting to compare such a curious abnormity of the integument with the similar abnormities which exist in the human species. The human fingers are most frequently connected together by syndactyli, and remain during life in that state of arrested development (as regards the integument) which is typified by the permanent stage of the development of the gorilla. On the other hand, I have never yet met, either in the chimpanzee or orang-utan, with a similar case of freedom of digits to that here described. We must, however, recollect that the number of specimens of chimpanzee and orang-

utan, which have been accurately described anatomically, form a very small percentage. How many individuals of gorilla may exist, in which there may be a similar 'accidental' variety, must remain for a long time unknown to us. Syndactylity is often congenital. A case has recently come before my observation of a married female, in which the *medius* and *annulus* of both hands are firmly connected together by integument. A similar condition prevails in one of her children; another has deformity on the right hand; while the youngest preserves the digits in their normal condition. The speculation whether a like rule or its converse may or may not prevail in the ape,—whether it might not through generations during which the congenital defect of the gorilla, or absence of the characteristic syndactylity, might be transmitted, operate towards the production of a more prehensile form of hand, must, however, be postponed until a vaster series of specimens shall be examined by anthropologists or zoologists."

'On the Physical and Mental Character of the Negro,' by Dr. J. Hunt.

This paper brought up Mr Craft, a negro of nearly pure black skin, in defence of his race. Mr. Craft said, that as Africans were very dark, and the inhabitants of Northern Europe very fair, and as, moreover, the nations of Southern Europe were much darker than those of Northern Europe, it was perfectly fair to suppose that climate had a tendency to bleach as well as to blacken. The thickness of the skulls of the negroes had been wisely arranged by Providence to defend their brains from the tropical climate in which they lived. If God had not given them thick skulls their brains would probably have become very much like those of many scientific gentlemen of the present day. The woolly hair was not considered by Africans as a mark of inferiority, though some of them shaved it off, but it also answered the purpose of defending the head from the sun. With regard to his not being a true African, his grandmother and grandfather were both of pure negro blood. His grandfather was a chief of the West Coast; but, through the treachery of some white men, who doubtless thought themselves greatly his superiors, he was kidnapped and taken to America, where he (Mr. Craft) was born. He had recently been to Africa on a visit to the King of Dahomey. He found there considerable diversities even among the Africans themselves. Those of Sierra Leone had prominent, almost Jewish features. Their heels were quite as short, generally, as those of any other race, and upon the whole they were well formed. Persons who had any knowledge of Africans knew that, when they enjoyed advantages, they were capable of making good use of them. He might refer to the instance of the little girl brought to this country by Capt. Forbes. This child was presented to the Queen, who had her carefully educated. When she grew up, she mingled in good society, and interested every one by her proficiency in music; and recently she had been married to a commercial gentleman of colour at Lagos. Another case was mentioned by Mr. Chambers in one of his works; and another case was that of Mr. Crowther, who was well known to many gentlemen in this country. One word with reference to the ancient Britons. When Julius Cæsar came to this country, he said of the natives that they were such stupid people that they were not fit to make slaves of in Rome. It had taken a long time to make Englishmen what they now were, and therefore it was not wonderful if the negroes made slow progress in intellectual development. It was, however, proved, that they made very rapid progress when placed in advan-

tageous circumstances. As to the negro not being erect, the same thing might be said of agricultural labourers in this country. He pointed to Hayti as furnishing an instance of independence of character and intellectual power on the part of the negro; and contended that in America the degraded position which he was forced to occupy gave him no chance of proving what he really was capable of doing. He was sorry that learned and scientific men should waste their time in discussing a subject that could prove of no benefit to mankind. He spoke with great defer ence to their opinions; but, for his own part, he firmly agreed with Cowper, that

Fleecy locks and black complexion
Cannot alter nature's claim;
Skins may differ, but affection
Dwells in white and black the same.

'Military Budgets of English and French Armies for 1863–4, statistically compared,' by Col. Sykes —He showed by a series of elaborate returns that the total effective English army was 147,118; that of the French, 355,187. The cost per head of the effective and non-effective English, numbering 147,118 men, was 94*l.* 1*s.* 1½*d.*, while that of the French effective and non-effective forces of 400,000 was 43*l.* 9*s.* 4*d.* per head. The cost of the British manufacturing department was 6*l.* 10*s.* per head, against 2*l.* 15*s.* 10*d.*; military stores (British) per head, 5*l.* 14*s.*, French, 3*l.* 0*s.* 2*d.*; purchase of small arms (British), 14*s.* 4½*d.*, against 5*s.* 8*d.*; British military education, 1*l.* 3*s.* 5*d.*, French, 7*s.* 1*d.*; administration of the British army (Secretary of State and Commander-in-Chief's Department), 1*l.* 8*s.* 11*d.*, French, 6*s.* 11½*d.*; Government staff (British) per individual 304*l.* 5*s.*, French, 390*l.*; clothing (British), 4*l.* 0*s.* 2*d.*, against 1*l.* 19*s.* 11*d.* Col. Sykes gave further details, showing the great difference in the amount of estimates required for the support of the British and French armies. He (Col. Sykes) expressed his opinion that economy would be secured in a much greater degree if the Government, instead of manufacturing themselves the *matériel* required for use in the army and navy, would intrust it to contractors. He had been hoping that the contrast between the expenditure on the French army and that on our own could have been satisfactorily explained, and that the French army was only one-half of our own. The details could not be gainsaid. Then, again, when a certain total sum was granted, there was the greatest possible vigilance exercised to insure that the sums appropriated to various purposes were actually spent in the department to which they were originally intended to be applied, or that they were clearly accounted or if not required. He had received a communication from a friend of his own of high position and fully acquainted with military matters, who, after making inquiries in the proper quarters, was of opinion that the administration of French military affairs was in a very healthy state indeed, and had exercised a most beneficial influence on the political condition of the country. No Englishman would for a moment begrudge the proper means of securing the respectability, the gentlemanly bearing, the self-respect of the common soldier even, but Englishmen did wish that, whatever public money was given for that purpose, should be devoted in the most economical manner to the purposes for which it was given. It was what the people of England had a right to expect; and his object in calling attention to those comparisons was that all those things might be looked into, and that, in future, there would be less cause for the army and navy to absorb nearly one-half of the taxes of the country.

RESEARCHES ON THE MOON.—BY PROF. PHILLIPS.

The author having on previous occasions presented his views as to the methods and objects of research in the moon, was desirous now to state a few results, and exhibit a few drawings, the fruit of recent examinations of the moon by means of a new eqnatorial by Cooke, with an object-glass of 6 inches. In sketching ring mountains, such as Theophilus and Posidonius, the author has been greatly interested by the changes of aspect which even a small alteration in the angles of elevation and azimuth respectively produce in the shadows and lights. Taking an example from Cyrillus, with its rocky interior, and fixing attention on the nearly central mountain, it always appears in the morning light to have two principal unperforated masses. By a slight change in the direction of the light, the division of these masses is deeply shaded on the north or deeply shaded on the south, and the figure of the masses, *i. e.*, the limit of light and shade, seems altered. A slight change in the angle of elevation of the incident light makes more remarkable differences. On Posidonius, which is a low, nearly level plateau, within moderately raised borders, the mid-morning light shows with beautiful distinctness the shield-like disc of the mountain, with narrow broken walls, and in the interior, broad, easy undulation one large and several smaller craters. In earlier morning more craters appear and the interior ridges gather to form a broken terrace subordinate to the principal ridge. This circumstance of an interior broken terrace, under the high main ring of mountain, is very frequent, but it is often concealed by the shadow of the great ridge in early morning shadows. To see it emerge into half-lights, and finally to distinct digitations and variously directed ridges, as the light falls at increasing angles, is a very beautiful sight. But it is chiefly to the variations in the central masses of lunar mountains and their physical bearings that the author wishes to direct attention. Many smaller mountains are simply like cups set in saucers, while others contain only one central or several dispersed cups. In Plato is a nearly central very small cup, bright, and giving a distinct shadow on the grey ground, as seen by Mr. Lockyer, Mr. Birt, and Prof. Phillips himself. But in the centre of many of the larger mountains, as Copernicus, Gassendi and Theophilus, is a large mass of broken rocky country, 5,000 or 6,000 feet high, with buttresses passing off into collateral ridges, or an undulated surface of low ridges and hollows. The most remarkable object of this kind which the author has yet observed with attention is in Theophilus, of which mountain two drawings are given, in which the author places equal confidence, except that the latter drawing may have the advantage of more experience. The central mass is seen under powers of 200—400 (the best performance is from 200 to 300), and appears as a large conical mass of rocks about fifteen miles in diameter, and divided by deep chasms radiating from the centre. The rock-masses between these deep clefts are bright and shining, the clefts widen towards the centre, the eastern side is more diversified than the western, and like the southern side has long excurrent buttresses. As the light grows on the mountain, point after point of the mass on the eastern side comes out of the shade, and the whole figure resembles an uplifted mass which broke with radiating cracks in the act of elevation. Excepting in steepness, this resembles the theoretical Mont d'Or of De Beaumont; and as there is no mark of cups or craters in this mass of broken ground the author is disposed to regard its origin as really due to the displacement of a solidified part of the

moon's crust. He might be justified by Prof. Secchi's drawing of Copernicus, in inquiring if the low excurrent buttresses may indicate issues of lava on the southern and western sides? On the whole, the author is confirmed in the opinion he has elsewhere expressed, that on the moon's face are features more strongly marked than on our own globe, which, rightly studied, may lead to a knowledge of volcanic action under grander and simpler conditions than have prevailed on the earth during the period of subaërial volcanoes. The author also exhibited a drawing of Aristarchus, showing some undescribed features in the aspect of that, the highest part of the moon's surface.

'On some Phenomena produced by the refractive power of the Eye,' by Mr. A. Claudet.—This paper was to explain several effects of the refraction through the eye, one of which is, that objects situated a little behind us, are seen as if they were on a straight line from right to left. Another, that the pictures of external objects which are represented on the retina, are included in an angle much larger than one-half of the sphere at the centre of which the observer is placed; from this point of view a single glance encompasses a vast and splendid panorama extending to an angle of 200°. This is the result of the common law of refraction. All the rays of light passing through the cornea, to the chrystalline lens are more and more refracted in proportion to the angle at which they strike the spherical surface of the cornea. Consequently, the only objects which are seen in their true position are those entering the eye in the direction of the optic axis. By this refraction the rays which enter the eye at an angle of 90°, are bent at 10°, and appear to come from an angle of 80°. This phenomenon produces a very curious illusion. When we are lighted by the sun, the moon, or any other light, if we endeavour to place ourselves in a line with the light and the shadow of our body, we are surprised to find that the light and the shadow seem not to be connected at all, and that, instead of being in a line, they appear bent to an angle of 160° instead of 180°, so that we see both the light and the shadow a little before us, where they are not expected to be. The eye refracts the line formed by the ray of light, and the shadow and the effect is like that of the stick, one half of which being immersed in water, appears crooked or bent into an angle at the point of immersion. This enlargement of the field of vision to an angle of 200°, is one of those innumerable and wonderful resources of nature by which the beauty of the effect is increased. Our attention is called to the various parts of the panorama which appear in any way a desirable point of observation, and we are warned of any danger from objects coming to us in the most oblique direction. These advantages are particularly felt in our crowded towns, where we are obliged to be constantly on the look-out for all that is passing around us.

On the Cultivation of Cinchona in India," by Mr. C. R. Markham.

Dr. Thompson said it was those only who knew how rapidly the supply of quinine from Chili and South America was being exhausted that could know how inestimable was the work which the paper described. The experiments which had been made had shown, not only that the plant might be grown in other countries, but that the bark of the young tree yielded a much larger proportion of quinine than that of the old. The good which would result from carrying the cultivation of the plant into new fields was immense; for while the application of quinine was

extending, many of the hospitals had had to restrict its use on account of the expense; and the result of the recent discoveries would be that physicians, when prescribing bark alone, would give the preference to young bark.

On the Reason why the Stomach is not Digested by its own Secretion during Life, by Dr. Pavy.—How is it (he observed) that the stomach, composed as it is of digestible materials, escapes being digested itself, whilst digestion is being carried on in its interior? The question here raised must be admitted to be one of the utmost interest and importance to us all, because it touches upon the means by which we escape after every meal we consume from the occurrence of an event which would inevitably prove fatal to life. Hunter noticed that the stomach was susceptible of being attacked by the digestive liquid after death, and accounted for its power of resisting destruction during life by reference to the 'living principle.' The stomach, he says, which at one instant, that is, while possessed of the living principle, was capable of resisting the digestive powers which it contained, the next moment, namely, when deprived of the living principle, is itself capable of being digested. In illustration, he further says, "if it were possible for a man's hand to be introduced into the stomach of a living animal, and kept there for some considerable time, it would be found that the dissolvent powers of the stomach could have no effect upon it; but if the same hand were separated from the body and introduced into the same stomach, we should then find that the stomach would immediately act upon it." This statement, however, fails to stand the test of actual experience. Bernard, of Paris, ingeniously contrived to introduce the hind legs of a living frog through a fistulous opening in the interior of a digesting stomach, and found that they underwent digestion, notwithstanding that the life of the animal was maintained. My own experience enables me to testify to the accuracy of this result; and further, I have found that the tip of a living rabbit's ear has similarly yielded to the influence of the digestive menstruum. The "living principle" must, therefore, be discarded, as insufficient to account for the state of security under which the living stomach exists. To replace the refuted influence of the "living principle," it has been suggested that it is the epithelial lining which gives to the stomach the immunity from destruction it enjoys during life. The stomach, it has been said, is lined with an epithelial layer, and this, with the mucus secreted, acts as a kind of varnish in protecting the deeper parts. Whilst digestion is proceeding, the epithelium and mucus are constantly being dissolved, like the food contained in the stomach; but a fresh supply being as constantly produced, the organ is thereby maintained intact. Death taking place, and the epithelial layer being no longer produced, the gastric juice, after acting upon and dissolving it, reaches the deeper coats, and then, continuing to exert its influence, may ultimately, the temperature being maintained sufficiently favourable for the purpose, occasion a perforation of the organ. This view, however, like Hunter's "living principle," fails to stand when submitted to the test of experiment; for I have found that a considerable-sized patch of mucous membrane may be removed, and food will afterwards be digested without the slightest sign of attack being made upon the deeper coats of the organ. Indeed, it might almost be assumed upon reflection, that something more constant—that some condition presenting less exposure to the chance of being influenced by external circumstances than that supplied by the existence of an epithelial layer, would be required to account

for that unfailing security from *ante mortem* solution which the stomach appears to enjoy. From the articles swallowed, abrasion of the mucous membrane may be presumed to have been not unfrequently produced, and ulceration is not of so uncommon an occurrence; yet perforation has not been observed as the necessary result. The problem, therefore, as to why the stomach is not susceptible of attack during life as it is after death, still remains open for solution; and the view that I have to offer refers the immunity observed to the circulation within the walls of the organ of an alkaline current of blood. It will not be disputed that the presence of acidity is one of the necessary circumstances for the accomplishment of gastric digestion. Now, alkalinity is a constant character of the blood, and, as during life, the walls of the stomach are everywhere permeated by a current of this alkaline blood, we have here an opposing influence, the effect of which would be to destroy, by neutralizing its acidity, the solvent properties of the digestive fluid tending to penetrate and act upon the texture of the organ. The blood being stagnant after death, the opposing influence is lost that is offered by the circulating current. Should life happen to be cut short at a period of digestion, there is only the neutralizing power of the blood actually contained in the vessels of the stomach, to impede the progress of attack upon the organ itself; and the consequence is, that digestion of its parietes proceeds, as long as the temperature remains favourable for the process, and the solvent power of the digestive liquid is unexhausted. There is, therefore, no want of harmony between the effect that occurs after death and the explanation that refers the protection afforded during life to the neutralizing influence of the circulation. In support of this view I have found, experimentally, that by arresting the flow of blood through the stomach during life, the organ is placed in the same condition as it is after death: having lost its protecting influence, digestion of its texture now proceeds. It will be naturally required of me to reconcile the view advanced, with the effect that is noticed when the living frog's legs and rabbit's ears were introduced through a fistulous opening into the digesting stomach. If the circulation, through its neutralizing power, protect the stomach, why should it not have afforded equal protection to the tissues of the living animals introduced through a fistulous opening into the organ? According to the proposition offered, the result is involved in a question of degree of power between two opposing influences. And because through degree of vascularity the neutralizing power of the circulation is sufficient to hold in check the solvent action of the gastric juice in the case of the walls of the stomach, it does not follow that it should similarly be sufficient to do so in the case of the frog's legs and rabbit's ears. With the frog it may be fairly taken that the amount of blood possessed by the animal would be totally inadequate to furnish the required means of resistance to the influence of the acidity of a dog's gastric juice. With the rabbit's ears the vascularity is so much less than that of the walls of the stomach that there is nothing incomprehensible in the fact of the one yielding to, and the other resisting the attack. In support of the position that has been taken, it can be shown by experiment that even with the stomach itself, by increasing the acidity of its contents beyond a certain point, its circulation is no longer adequate to enable it to resist digestion.

ENTOMOLOGICAL SOCIETY OF CANADA.

The ordinary monthly meeting of the society was held in the Council-room of the Canadian Institute, on Tuesday, the 8th December, at three o'clock, p.m Nearly all the members from Toronto and the vicinity were present.

In the absence of Prof. Croft and Mr. Saunders, Dr. Morris was called to the chair, and Mr. Hubbert appointed secretary, *pro. tem.* The minutes of the previous meeting were read and confirmed.

Communications were received from

Professor Hincks, expressing regret at his inability to attend, in consequence of indisposition;

F. Grant, Esq., and R. V. Rogers, Esq., on business connected with the society.

The following gentlemen were proposed as suitable persons to become members of this society:

The Rev. H. P. Hope, Toronto.
Rice Lewis, Esq., "
James Wright, Esq., Vienna.

The following donations were acknowledged, and the thanks of the society voted to the donors:

From Prof. Croft—
A cabinet of seven drawers.

To the Library:

From the Smithsonian Institution—
Monographs of the Diptera of North America. By H. Laen. Part I.

From the author, W. Saunders, Esq., London, C. W.—
(1) Monograph of the Arctiadæ of Canada. 20 copies.
(2) Description of two new species of Arctia.
(3) "On some hitherto undescribed Lepidopterous larvæ."

From A. L. Packard, Jun., Esq., Cambridge, Mass., through Principal Dawson—
Photographs of the following undescribed Bombyces: Crambuda pallida, Callimorpha vesta, Callochlora chlorata, Cyrtosia albopunctata ♂ and ♀, Entortricallis testacea, Cyrtosia geminata, Cilodasys cinereafrons, Laphodonta ferruginea, Gluphisia trilineata ♂ and ♀, Platycorura furcilla, Cilodasys biguttata, and Edapleuza bilineata.

From James Hubbert, Esq., B.A.—
Popular Entomology. By Maria E. Catlow.
British Butterflies. By W. S. Coleman.

To the Cabinet:

From Prof. Croft—
48 Specimens, including 27 species of Chinese Lepidoptera.
164 " " 61 " Coleoptera.

From B. R. Morris, Esq., B.A., M.D.—

47 Specimens, including 16 species of Coleoptera.

From J. H. Sangster, Esq., M.A.—

28	Specimens,	including	17	species of	Coleoptera.
6	"	"	5	"	Lepidoptera.
11	"	"	10	"	Diptera.
10	"	"	10	"	Hymenoptera.
5	"	"	4	"	Neuroptera.
4	"	"	4	"	Orthoptera.

From B. Billings, Esq., Ottawa—

236	Specimens,	including	132	species of	Coleoptera.
21	"	"	19	"	Lepidoptera.
6	"	"	5	"	Diptera.
7	"	"	5	"	Orthoptera.
3	"	"	2	"	Strepsiptera.
3	"	"	3	"	Hemiptera.

From James Hubbert, Esq., B.A.—

251	Specimens,	including	176	species of	Coleoptera.
63	"	"	25	"	Lepidoptera.
49	"	"	40	"	Diptera.
38	"	"	27	"	Hymenoptera.
12	"	"	10	"	Orthoptera.
12	"	"	8	"	Neuroptera.
15	"	"	10	"	Hemiptera.

From Thomas Reynolds, Esq., Montreal—

13	Specimens,	including	8	species of	Coleoptera.
154	"	"	53	"	Lepidoptera.
1	"	"	1	"	Diptera.
9	"	"	6	"	Hymenoptera.
2	"	"	1	"	Hemiptera.

From Wm. Saunders, Esq., London—

345	Specimens,	including	121	species of	Coleoptera.
111	"	"	37	"	Lepidoptera.
1	"	"	1	"	Diptera.
8	"	"	5	"	Neuroptera.
4	"	"	1	"	Strepsiptera.

A communication was read from Mr. Saunders, regarding the practicability of publishing a catalogue of the known Canadian species of each order of insects. After considerable discussion as to the best form, &c.,—

It was moved and seconded,—That the society take immediate steps to prepare and publish catalogues of the Coleoptera and Lepidoptera, to be followed by

similar catalogues of the other orders as soon as possible; and that Mr. Saunders, Prof. Croft, and Mr. Billings, be a committee on Coleoptera; and Prof. Hincks, Mr. Saunders, and Dr. Morris, on Lepidoptera.—Carried.

The committee are very anxious to secure the co-operation of all persons having either named collections or lists of species. Any information which would aid in bringing out full and accurate catalogues, should be communicated without delay to Mr. Saunders or Prof. Hincks.

Moved and seconded,—That a supply of entomological pins and sheet cork, for lining cabinets, be kept on hand, to be furnished to members at the lowest cost prices.—Carried.

It is intended ultimately to keep all the apparatus required in capturing and preserving insects.

Moved and seconded,—That the Rev. Charles Bethune, B.A., be requested to use influence to advance the interests of this society among Naturalists in Great Britain.—Carried.

A verbal communication was made by Dr. Morris, on insects captured in the vicinity of Orillia, during the summer of 1863. Among the interesting specimens exhibited by Dr. Morris, were several examples of *Colias edusa*, so seldom met with in Canada,—only two or three individuals having been taken as yet. Dr. Morris remarked that this insect seems to differ from the *C. edusa* of British Naturalists, in its habits of flight, &c., which seems to indicate either a distinct species or very wide variations.

Both sexes of *Terias lesa*, also very rare in Canada, had been captured.

A species of *Anhenodes*, taken by Mr. F. Grant, of Orillia, was also exhibited. The general appearance of the insect closely resembled that of *A. septentrionis*, of which it is probably a variety. The form of the rostrum is so peculiar, as to lead Dr. Morris to think that possibly there may be two species with us.

The following papers were presented by Mr. Hubbert:

(1) Notes on insects captured near Kingston. 1863.
(2) What the insects do in January.

The meeting then adjourned.

CANADIAN INSTITUTE.

ANNUAL REPORT OF THE COUNCIL FOR THE YEAR 1863.

The Council of the Canadian Institute have the honour to present the following Report of the Proceedings of the Society for the past year:

I.—Membership.

The present state of the membership is as follows:

Members at commencement of Session—December, 1862	447	
New Members elected during Session 1862–63	18	
By the Council during the recess of 1863	3	
		468
Deduct—Deaths	3	
Withdrawn	16	
Left the Province	3	
Non-payment	1	
		23
Total—30th November, 1863		445

Composed of—Honorary Members	4
Life Members	32
Corresponding Members	6
Junior Members	3
Ordinary Members	400
Total	445

The Council have to deplore the loss, during the past year, of Sir John Beverley Robinson, Bart. The active interest which he evinced in the prosperity of the Institute, and the valuable services which he rendered to it, will long be held in grateful recollection. Death has also removed Mr. Justice Connor and John Hutchinson, Esq., who, although they did not take part in the proceedings of the Society, yet lent their aid in promoting its welfare.

II.—Communications.

The following list of papers, read at the ordinary meetings held during the session, will be found to contain many valuable communications, and some of general interest:

13*th December*, 1862.

Rev. Prof. Hincks, F.L.S., &c., "On certain Vegetable Monstrosities considered in reference to the question of the reality and permanence of Species amongst organized beings."

P. Freeland, Esq., exhibited and described Smith and Beck's New Universal Microscope.

20th December, 1862.

Prof. H. Y. Hind, M.A., F.G.S., &c., "On Vegetable Parchment, its uses and preparations."

10th January, 1863.

The Rev. J. McCaul, LL.D., read the "Annual Address."

17th January, 1863.

Prof. D. Wilson, LL.D., "On the Characteristics of the Flint Implements of the Drift as compared with those of a later Stone Period."

John Martin, Esq., LL.D., "On some General Properties of Curves."

24th January, 1863.

A. E. Williamson, Esq., "A proposed Classification of the Genus Helix."

Professor J. B. Cherriman, M.A., (1) "Remarks on Comets." (2) "On Poinsot's memoir on Rotation."

31st January, 1863.

No papers.—Death of the late Chief Justice Robinson.

7th February, 1863.

Prof. G. T. Kingston, M.A., "Meteorological Report of 1862."

James Hubbert, Esq., "On the Fungi."

B. R. Morris, M.D., "On the Natural Checks to the Destruction of our Crops by Insects."

14th February, 1863.

Prof. G. T. Kingston, M.A., "On the Disturbance of Magnetical Declination at Toronto, during the years 1855–1862, inclusive."

Prof. D. Wilson, LL.D., "Relative to a new kind of Cannon which was described to him on his recent visit to Washington."

21st February, 1863.

U. Ogden, Esq., M.D., "On Chloroform and its effects."

T. J. Cottle, Esq., "On a new Species of Astacus,"

28th February, 1863.

Sandford Fleming, Esq., C.E., "On the present condition of the Enniskillen Oil Wells."

The Rev. Prof. Hincks, F.L.S., &c., "On the position and relations of certain families of Birds."

W. Saunders, Esq., "Catalogue of Plants found near London, C. W.,"

7th March, 1863.

Prof. D. Wilson, LL.D., "Notes of a recent Visit to the Mortonian Collection of the Academy of Natural Sciences of Philadelphia."

14th March, 1863.

Professor Hind, M.A., F.G.S., "On the Masquapees."

28th March, 1863.

P. Freeland Esq., "On the Measurement of Microscopic Objects."

The President, the Rev. J. McCaul, LL.D., "On the determination of Ancient Roman dates."

J. Bovell, Esq., M.D., "On Growth and Repair."

11*th April*, 1863.

Prof. E. J. Chapman, Ph.D., "On a Specimen of Carbonaceous matter from Lake Superior, with remarks on the Origin of the Petroleum, as applied more particularly to the Oil District of Western Canada, and some new views on the general formation of Coal."

18*th April*, 1863.

Rev. H. Scadding, D.D., "On Phonetic Anomalies observed in some modern forms of ancient proper names."

Rev. Prof. G. P. Young, M.A., "Formulæ for the cosines and sines of multiple arcs."

W. Saunders, Esq., "On Canadian Arctiadæ."

25*th April*, 1863.

Sandford Fleming Esq., C.E., "Notes on projected Canadian Canals to connect the Upper Lakes with the St. Lawrence."

The increase in the number of original papers and of contributors is a gratifying feature of the year. The number of our active members is still, however, too limited, and further coöperation is earnestly invited.

III.—Report of Editing Committee of the Journal.

"Your Committee have little to report on this occasion, beyond stating the fact of the completion of the Eighth Volume of the *Journal*, and expressing the hope that its usefulness has not been deteriorated below its predecessors. The general plan of the publication has in no respect been changed, although a larger number than usual of original communications has this year entered into it, and it is thus acquiring more and more the character which the Institute designed it to bear, namely, a record of the proceedings of the Society. No less than *twenty-six* such communications have been given, all of them bearing more or less closely on scientific or literary progress in connection with the Province. In addition to these, several translations of important articles from foreign sources, not otherwise accessible to the English readers, have been furnished, as well as Reviews on subjects of prominent interest, which may fairly claim for the most part to be considered as essays on those subjects of independent value. The Committee desire to express their obligations to Mrs. M. M. Kingsford and S. Kingsford, Esq., for valuable aid in this department. It was deemed advisable to curtail the space allotted to miscellaneous intelligence, or extracts from other journals, in order not to increase the cost of the *Journal* beyond its usual limit. In view of the reduction of the Government Grant to the Institute, of the withdrawal of the order for the supply of copies of the *Journal* to the Parliamentary Library Committee, and of the necessity that has otherwise arisen for economy in the affairs of the Institute, it is proposed to reduce the issue of the *Journal* to 500 copies, which will be sufficient for present need, and

will leave a margin for future wants. The cost of publication of the *Journal* has amounted to $1348.

"All which is respectfully submitted.

"J. B. Cherriman, *General Editor.*"

The Council have much satisfaction in noticing that the *Journal* continues its high reputation as a Scientific and Literary Periodical.

IV.—Report of Treasurer.

Statement of the Canadian Institute General Account, for the Year 1862–63, *from* 1*st December*, 1862, *to* 30*th November*, 1863:

Dr.		£	s.	d.
Cash—Balance last year		389	13	1
" Received from members		163	10	0
" " for Journals		49	11	10½
" " for Interest and Rent		91	10	8
" " due by Members		455	16	3
" " due for old Journal	£28 11 3			
" " due for new Journal	55 1 3	83	12	6
" Parliamentary Grant (not received)		187	10	0
		£1421	4	4½

Cr.	Cash paid on account of Journal.	£	s.	d.
Cash paid on account of Journal in the year 1862	£53 18 1			
" " " " 1863	197 7 0½	251	5	1½
" " for Library and Museum		61	9	9
" " on account of sundries		222	1	8
" " due on account of Journal for the year 1863		62	0	0
" " due on account of Sundries		38	8	4
" " due on account of Library		8	0	0
Estimated Balance		777	19	6
		£1421	4	4½

The Treasurer in account with the Canadian Institute, for the Year 1862–63, *from* 1*st December*, 1862, *to* 30*th November*, 1863:

Dr.	£	s.	d.
Cash—Balance last year	389	13	1
" Interest received on Securities	64	16	8
" Received from Members	163	10	0
" " on account of Journal	49	11	10½
" " for Rent	26	14	0
" Securities paid	150	0	0
" " "	75	0	0
" " "	500	0	0
" Securities held	775	0	0
	£2194	5	7½

Cr. *Cash paid on account of Journal.*

Cash paid for Journal for the year 1852	£53	18	1	251	5	$1\frac{1}{2}$
" " " 1863	197	7	$0\frac{1}{2}$			
" paid on account of Library and Museum				61	9	9
" paid on account of Sundries				222	1	8
" paid for Lot and Conveyance				662	10	0
Securities				775	0	0
Balance in Bank				221	19	1
				£2194	5	$7\frac{1}{2}$

Statement of the Building Fund.

Balance from last year	2140	1	9
Received Interest on Loans	64	16	8
" Rent	26	14	0
Subscriptions (uncollected)	534	15	0
	£2766	7	5
Cash paid for Lot and Conveyance	662	10	0
Balance	2103	17	5
	£2766	7	5

D. Crawford, *Treasurer.*

V.—Report of Auditors.

Toronto, 12th December, 1863.

Compared the vouchers with the cash-book. Balance due by Treasurer, £221 19s. 1d. [Two hundred and twenty-one pounds nineteen shillings and one penny.]

Sam. Spreull, G. H. Wilson, } *Auditors.*

VI.—Report of Librarian.

The additions to the Library of the Institute during the year 1863, have not been very numerous. They consist principally of the Reports and Transactions received from the Scientific Societies of Europe and the United States.

In addition to its own publications, the Smithsonian Institution has transmitted valuable reports from the Royal Dublin Society, and from several German and Scandinavian Scientific Associations.

From the Hon. J. M. Broadhead, of Washington, have been received eight official reports on Statistics, &c. Through Professor Hincks, fourteen volumes (in parts) of the Linnean Society's Journal have been presented.

The fourth volume of Agassiz's Contributions to the Natural History of the United States,—the gift of the late Sir John Beverley Robinson,—has arrived, rendering the work, so far as published, complete.

The Scientific Reports comprise thirty-four bound volumes, forty-five unbound volumes, and about sixty-seven pamphlets.

Ten sheets (all published) of a very valuable Ethnological Map of Finmark have been transmitted by the Smithsonian Institution. A Chart of Lake Ontario has been presented by Mr. Chewett. Mr. Bohn has sent—through Messrs. Rollo and Adam—the three latest additions to his interesting series of Libraries. A copy of the Statutes of Canada for 1863, has been received from the Record Office, Quebec.—These works, amounting in all to a little over one hundred and fifty, constitute the donations of the year.

The additions to the Library by purchase during the same period have been comparatively few. In view of the proposed commencement of a building by the Institute, economy in this, as in every other direction, seemed desirable. The volumes purchased amount to only eighteen. These include four volumes in continuation of series in course of publication, viz., three volumes of Bacon's Works, the third volume of Carlyle's Life of Frederick II., the third volume of Smiles' Lives of the Engineers, and the second volume of May's Constitutional History of England.

Detailed lists of all books, pamphlets, and maps received, are appended below.

About seventy volumes belonging to the Library are out on loan: many of them since 1861; some ten of them since 1858. Members when applied to by circular on the subject of these loans, do not in every instance respond. It seems desirable that there should be a return of all borrowed books at least once a year.

In regard to ordering books, it is important that in every instance the title of the work should be entered first in the order-book of the Institute: there is otherwise a danger of duplicates arriving to the address of the Institute. It is also important that every volume should be entered in the Librarian's Catalogue before passing into the hands of members.

The present Library is becoming somewhat over-crowded; but some space has been gained by placing two rows on one shelf, where the size of the volumes admitted of that arrangement.

H. Scadding,

Toronto, Dec. 5th, 1863. *Librarian Canadian Institute.*

VII.—Report of Building Committee.

In the spring of the year, the Society purchased an eligible lot of land as a site for a building, in which the business of the Institute might be satisfactorily conducted, and designs were submitted and approved. The following report states the causes which prevented the Building Committee from carrying out the intention of the Society. The plans, which have been adopted, provide ample and convenient accommodation, and the Council trust that the funds of the Institute may soon be sufficient to warrant the commencement either of the projected building or of one on a smaller scale.

REPORT.

"The Building Committee report that the tenders which they received for the building, so far exceed the expectation of the Council and the means at the dis-

posal of the Institute, that they have deemed it necessary to bring the whole subject again under the consideration of the Council.

"The amount of the lowest tender sent in for the carpenters' and masons' department, was $9,924.00; and the only reductions which the architect suggested, amounted to $1,319.00,—leaving $8,605.00 as the cost of the building. But to this must be added the necessary expenditure on light, heating, and fencing, which would be about $1,200; so that the minimum cost may be assumed at about $10,000,—being so far in excess of available funds that the Committee did not feel warranted in undertaking the building.

"JOHN McCAUL, *Chairman.*"

VIII.—MEDICAL SECTION.

During the past year, a section for the cultivation of Medical Science was formed. Its meetings have been regularly held, and much valuable information has been communicated in the papers which have been read, and in the discussions which have arisen.

REPORT.

Since the organization of this section, on the 1st of April last, six regular meetings have been held, at which the following papers were read by the respective authors, viz.:

1. "On the treatment of Asthma by Acetic Acid" .. ... Dr. C. B. Hall.
2. "On Hybridity".. Dr. Barrett.
3. "On Food".. Dr. Thorburn.
4. "On Hip Joint disease"............................... Dr. Clarke.
5. "On the law of the continuous development of Cells".. Dr. O'Dea.
6. "On the Yellow Spot of Sœmmering"................ Dr. Barrett.

UZZIEL OGDEN, *Chairman.*

Toronto, December 12th, 1863.

IX.—THE ENTOMOLOGICAL SOCIETY OF CANADA.

This Society, which holds its meetings in the rooms of the Institute, was also formed during the past year, for the encouragement of the study of the important branch of Natural History, from which it derives its name. Its progress is a satisfactory earnest of its future success.

REPORT.

The following are a few of the points of interest connected with our Entomological Society.—The first meeting was held on Thursday, the 16th of April. As the summer vacation has occupied most of the intervening time only two other meetings have yet been held. The Society numbers thirty-six members, all of whom are actual working Entomologists. Eight papers have been read; and several valuable contributions to the Library have been received. The donations to the Reference Cabinet, which is the property of the Institute, comprise—

235	Species of	Coleoptera.
76	"	Lepidoptera.
43	"	Diptera.
35	"	Hymenoptera.
8	"	Orthoptera.
8	"	Neuroptera.
18	"	Hemiptera.
2	"	Strepsiptera.

Duplicates of many of these have been received, swelling the whole number received to 1480 specimens. Most of these duplicates will be used for effecting exchanges, and thus will ultimately go to increase the collection in the reference cabinet.

JAMES HUBBERT,
Curator.

The Council, in conclusion, desire to express their regret, that the Institute was deprived, during the latter part of the year, of the valuable assistance of their Recording Secretary, Patrick Freeland, Esq. Serious illness compelled him to resign the office, which he had so efficiently occupied. The Council sincerely trust that restorsd health may permit him again to take part in the Society's proceedings. The duties of the vacant office were kindly undertaken by the Corresponding Secretary, Dr. Morris.

JOHN McCAUL,
President.

APPENDIX.

DONATIONS OF BOOKS, MAPS, &c., SINCE LAST ANNUAL REPORT.

Those marked thus * are not bound.

From the Vermont State Library, Montpelier, Vermont, U. S. VOLS.

The Geology of Vermont, &c. Vols. 1 and 2. By Ed. Hitchcock, LL D.; Ed. Hitchcock, Jr., M.D. ; Albert D. Hager, A.M. ; and C. H. Hitchcock, A.M. 2

From the Hon. J. M. Brodhead, Washington.

Patent Office Reports. Agriculture. 1861 1

Preliminary Report, Eighth Census, 1860, United States. By Joseph C. G. Kennedy, Superintendent 1

Annual Report of the Board of Regents of the Smithsonian Institution, for the year 1861 1

Results of Meteorological Observations made under the direction of the United States Patent Office and the Smithsonian Institution, from the year 1854 to 1859, inclusive. A Report of the Commissioner of Patents, 1st Session, 36th Congress. Vol. 1. Washington, 1861 1

Fourth Meteorological Report of Prof. J. P. Espey. Washington, 1854.... 1

VOLS

Report on the Art of War in Europe, in 1854, 1855, and 1856. By Major Richard Delafield, Corps of Engineers. Washington, 1860 1

Military Commission to Europe, 1855 and 1856. Report of Major Alfred Mordecai, Ordnance Department. Washington, 1860 1

The Commercial Relations of the United States with Foreign Nations, for the year ending September 30th, 1861. Washington, 1862 1

From the National Association for the Promotion of Social Science, per the Hon. G. W. Allan, M.L.C.

Transactions of the National Association for the Promotion of Social Science, 1860 and 1861 2

From the Hon. Sir J. B. Robinson, Bart.

Contributions to the Natural History of the United States. By Louis Agassiz. Vol. 4 1

Presented by the Author.

Britanno-Roman Inscriptions. By the Rev. John McCaul, LL.D., Pres. Univ. College, Toronto................. 1

From the Government of India.

Magnetical and Meteorological Observations made at Bombay in 1860 1

From the respective Societies.

Transactions of the Royal Irish Academy. Vol. 24.—Part II. Science 1*

Proceedings of the Literary and Philosophical Society of Liverpool, 51st Session. 1861–62. No. 16 .... 1*

Transactions of the Royal Society of Edinburgh. 1857–58. Vol. 22. Part I. 1*

" " " " 1558–59. Vol. 23. Part I. 1*

From the University of Norway.

Recherches sur la Syphilis Appuyées de Tableaux de Statistique Tirés des Archives des Hôpiteaux de Christiania. Par W. Boeck, &c. 1862.... 1*

Ten Maps.. 10

Die Culturpflanzen Norwegens Beobachet Von Dr. F. C. Schubeler. 1862.. 1*

Geologiske Undersogelser i Bergens omegn af Th. Hiortdahl og M. Irgens. 1862 .... 1*

Beskrivelse over Lophogaster Typicus, &c., af Dr. Michael Sars · 1*

Forhandlinger Videnskabs—Selskabet i Christiania. Aar, 1861 .... 1*

Meteorologische Beobachtungen Aufgezeichnet auf Christiania's Observatorium. Lieferung I. and II.... .... 1*

Generalberetning fra Gustad Sindssygeasyl for Aaret 1861 .... 1*

Beretning om Bodsfaengflets Virksomhed i Aaret, 1859................. 1*

From Smithsonian Institution—supposed from Society.

Verhandlungen der k. k. Zoolog.-botanischen Gesellschaft in Wien Jahrgang, 1861 .... 1*

Nachtrage zu Maly's Enumeratio plantarum phanerogamicarum imperii Austriaci Universi. Von August Neibreich. Wein, 1861 .... 1*

Bericht über die Thätigkeit der St. Gallischen naturwissenschaftlichen Gessellschaft Während des Vereinsjahres. 1861–62. (Redaktor. Prof. Dr Wartman.) St. Gallen, 1862 .... 1*

From the Royal Dublin Society, per Smithsonian Institution, VOLS

Journal of the Royal Dublin Society—January and April, 1861 .... 1*
" " " July and October " 1*
" " " January, 1862 .... 1*
" " " April " 1*

From the State of Wisconsin, U. S., per Smithsonian Institution.

The Geology of Wisconsin. Vol. 1. Hall and Whitney, 1862 1

From the United States Patent Office, Washington.

Patent Office Reports, 1860. Vol. 1. Mechanics 1
" " " Vol. 2. " 1
" " 1861. Agriculture 1

From Dr. Oldham, Superintendent of the Geological Survey, India.

Memoirs of the Geological Survey of India. Vol. 4, Part 1 .... 1*
Annual Report of do. do. do. for 1861-62 .... 1*
Memoirs of the Geological Survey of India—Palæontologia Indica—2. 1. The Fossil Flora—Rajmahal Hills 1*
Do. do. do 2. 2. .... 1*

From the Office of Routine and Record.

The Statutes of Canada, for 1863 .... 1*

From W. C. Chewett & Co., Toronto.

Chart of Lake Ontario 1

From H. G. Bohn, Esq., London.

The Historical Works of Giraldus Cambrensis Revised. By Thos. Wright. 1863 1
Demosthenes' Miscellaneous Orations, with Index 1
Lownde's Bibliographer's Manual. Vol. 4, Part 2 1

From Vienna, through the Smithsonian Institution.

Mittheilungen der Kaiserlich—Königlichen Geographischen Gesellschaft,

I.	Jahrgang,	1857.	Heft 1..	1*
I.	do.	"	" 2..	1*
II.	do.	1858.	" 1..	1*
II.	do.	"	" 2..	1*
II.	do.	"	" 3..	1*
III.	do.	1859.	" 1..	1*
III.	do.	"	" 2..	1*
III.	do.	"	" 3..	1*
IV.	do.	1862		1*

From Leonard Scott & Co., New York.

Reviews—Westminster, Edinburgh, London, North British, and Quarterly; and Blackwood, monthly. Each one set 1

From B. Quaritch, London.

Catalogue Raisonneé of Rare and Valuable Books, 1863 12

DONATIONS OF PAMPHLETS, SHEETS, &c.

From J. Hall, Albany, New York. — VOLS

Fifteenth Annual Report of the Regents of the University of the State of New York, on the condition of the State Cabinet of Natural History and the Historical and Antiquarian Collection annexed thereto. Apl. 12th, 1862 5

Contributions to Palæontology. By James Hall 5

Notice of some New Species of Fossils from a locality of the Niagara Groupe, in Indiana, with a list of Identified Species from the same place. By J. Hall 1

From Harvard College, U. S.

Report of the Committee of the Overseers of Harvard College, appointed to visit the Library, for the year 1862, &c 1

From J. W. Dawson, LL.D., F.G.S., &c. (the author.)

On the Flora of the Devonian Period, in North Eastern America 1

Air Breathers of the Coal Period, Nova Scotia 1

From Samuel Spreull, Esq., Toronto.

On Ribs and Transverse Processes, with special relation to the theory of the Vertebrate Skeleton. By J. Cleland, M.D 1

On the relations of the Vomer, Ethnoid, and Intermaxmillary Bones. By J. Cleland, M.D 1

From the Linnæan Society, London, per Rev. W. Hincks. — PARTS

Botany—Vol 1. Nos. 1—4 .... 4*
" 2. 5—8 .... 4*
" 3. 9—12 .... 4*
" 4. 13—16 .... 4*
" 5. 17—20 .... 4*
" 6. 21—24 .... 4*
" 7. 25, 26 .... 2*

Supplement to Botany. Nos. 1 and 2. Vol. 1 .... 2*
" " Vol. 4 .... 1*
" " " 5 .... 1*

Second Supplement to Botany. Vol. 5 .... 1*

Zoology—Vol. 1. Nos. 1—4 .... 4*
" 2. 5—8 .... 4*
" 3. 9—12 .... 4*
" 4. 13—16 .... 4*
" 5. 17* 17—20 .... 5*
" 6. 21—24 .... 4*
" 7. 25, 26 .... 2*

The President's Address, and List of Members of Linnæan Society, for 1862 .... 2*

From Prof. Kingston, Magnetic Observatory, Toronto. — VOLS.

Abstract of Magnetical Observations made at the Magnetic Observatory, Toronto, C. W., 1856—1862, inclusive, and parts of 1853—1855 1

From the Society, per Dr. D. Wilson. PAMPHLETS

Annals of the Botanical Society of Canada, Vol. 1, Part I., from 7th Dec., 1860, to 8th March, 1861 1

From S. Fleming, Esq.

Memorial of the People of Red River 1

From McGill College, Montreal.

Faculty of Medicine, 1863–1864 1

From T. C. Keefer, Esq.

Descriptive Catalogues, Exhibition; London, 1862.

- Jamaica 1
- Trinidad 1
- Venezuela 1
- New South Wales 1
- Victoria, Australia 1
- Norway (Vegetable Productions) 1
- Russian Section 1
- Zollverein, Mining &c 1
- Belgium 1
- Paris Artistical Bronze 1

From E. A. Meredith, Esq., Quebec.

Report of the Board of Inspectors of Asylums, Prisons, &c., 1862 1

From T. C. Wallbridge, M. P. P.

Third Military District Rifle Association of Upper Canada Rifle Match on Barriefield Common, Pittsburgh Sept., 1863 1

Lectures on Canada. By the late Mr. Charles Bass 1

Letter to the Right Hon. C. B. Adderly, M. P., on the relations of England with her colonies. By Hon. Joseph Howe, Premier of Nova Scotia 1

Annuaire de L'Université-Laval Pour L'Année Academique, 1863, 1864 1

Copies of all Reports of any Officers of the Public Works, 9th Sept., 1863.

District Town of Kamouraska, Change of 1

Bill for protection of growing timber 1

Return for Copies of Correspondence and Papers relative to certain Bonds of Grand Trunk Railway Co 1

Act, the City of Montreal to aid the G. T. R 1

Act connected with the Peterborough and Port Hope Railway 1

Act, Stanstead Railway 1

Report of the Library of Parliament 1

The Post Office contract, Montreal Ocean Steamship Company 1

From the Trustees of the New York State Library, Albany.

45th Annual Report of the Trustees of the New York State Library, April 7, 1863 2

16th Annual Report of the Trustees of the New York State Cabinet of Natural History, &c., April 15, 1863 10

76th Annual Report of the Regents of the University of the State of New York, March 4, 1863 6

In Exchange for Journal, 1863.	PAMPHLETS
The Journal of the Society of Arts, 1863	1
The Journal of Education, Upper Canada (Duplicate)	1
The Journal of the Franklin Institute, Philadelphia, 1863	1
The Artizan, 1863, London	1
Silliman's American Journal, 1863	1
Canadian Naturalist and Geologist, 1863	1
Transactions of the Royal Scottish Society of Arts. Vol VI., Part I	1
Proceedings of the Academy of Natural Sciences, Philadelphia, 1863	1
Historical Recollections of the Essex Institute, 1863	1
Annales des Mines, &c., France.	
Tome II. 4 Livraison de 1862, 6 Series	1
" 5 " " "	1
" 6 " " "	1
III 1 " " 1863 "	1
" 2 " " "	1
Proceedings of the Boston Natural History Society	1
The Canadian Agriculturist, Upper Canada, 1863	1
Journal of the Board of Arts and Manufactures, 1863	1
The Journal of the Royal Dublin Society	
No. 20 and 21, January and April, 1861	1
No. 22 and 23, July and October, 1861	1
No. 24, January, 1862	1
No. 25, April, 1862	1
No. 26, 27 and 28, July, 1862, to January, 1863	1
Transactions of the Royal Society of Edinburgh for the Session 1857–58 and 1858–59. Vol. 22, Part 1	1
Transactions of the Royal Society of Edinburgh for the Session 1861–62. Vol. 23, Part	
Transactions of the Academy of Sciences, St. Louis. Vol. II., No. 1	1
Transactions of the Royal Irish Academy. Vol. 24, Part 2. Science	1
Proceedings of the American Geographical and Statistical Society, New York, 1862–63. No. 1, Vol. 1; No. 2, Vol. 1; and Session 1862–63	3
Transactions of the Literary and Historical Society of Quebec. New Series. Vol. 1, Part 1	1
The Anthropological Review. No. 1, May, 1863	1
The British American Magazine, 1863	1

BOOKS PURCHASED.	VOLS
The Microscope and its revelations. By W. Carpenter, M.D., 1862	1
Smiles' Lives of the Engineers. Vol. 3	1
The Book Hunter, &c. J. Hill Burton	1
The English Language and its early Literature. By G. P. Marsh	1
The Works of Bacon. Vol. 5, 6 and 7	3
Allibone's Dictionary of Authors. Vol. 1	1
The Tropical World. Hartwig	1

	VOLS
Leyell's Antiquities of Man. English Edition	1
British Columbia and Vancouver's Island. Mayne	1
Memoirs of Prince Albert	1
Lewis Astronomy of the Ancients	1
History of Fredrick II. of Prussia, called Frederick the Great. By Thomas Carlyle. Vol. 3	1
Constitutional History of England. Vol. II. Mayo	1
The Geological Evidences of the Antiquity of Man. By Sir J. Lyell. Am. Ed., Philadelphia	1
Kingslake's Crimea. Vol. 1	
History of the Intellectual developement of Europe. By Dr. J. W. Draper	1

BOOKS BINDING FROM PERIODICALS.

Athenæum, January to June, 1863	1
" July to Dec., 1862	1
Illustrated London News, July—Dec., 1862	1
" " January—July, 1863	1
Mining Journal, 1862	1
Builder, 1862	1
Civil Engineer and Architects' Journal, 1862	1
The Art Journal, 1862	1
Chemical News, 1862	1
Blackwood, January—June, 1858	1
" July—Dec., 1858	1
" July—Dec., 1862	1
" January—June, 1863	1
Reviews, Westminster, 1862	1
" North British, 1862	1
" North American, 1862	2
" do 1863	1
" Natural History, 1862	1
" Edinburgh, 1862	1
Journal, Board of Arts and Manufactures, 1862	1
" Franklin Institute, July—Dec., 1862	1
London, Dublin, and Edinburgh Philosophical Magazine, July—Dec., 1862	1
Quarterly Journal of Microscopical Science, 1862	1
Edinburgh New Philosophical Journal, July—October, 1862	1
" " " January—April, 1863	1
Journal of Education, Upper Canada, 1861 and 1862	1
Proceedings of the Academy of Natural Sciences of Philadelphia, 1862	1
Historical Collections of the Essex Institute, 1862	1
Journal of the Society of Arts, 1861	1
Canadian Naturalist and Geologist. Vol. 7, 1862	1

	VOLS
Canadian Agriculturist, 1860 and 1862	2
Canadian Journal, 1862	2
Silliman's Journal, July—Dec., 1862	1
Total	36

ABSTRACT OF THE VOLUMES IN THE LIBRARY.

	Vol's. Bound.	Vol's. not Bound.
Compartment A.	302	31 in 100 parts.
" B.	283	5 " 5 "
" C.	328	4 " 25 "
" D.	301	5 " 5 "
" E.	305	9 " 8 "
" F.	307	6 " 6 "
" G.	302	10 " 130 Law Reports.
" H.	136	71 " 107
" I.	199	26 " 23
Lent Numbers,	56	- 28
Office,	13	12 in parts.
Table,	42	
Binding,	36	
	2610	179
	179	
Total Volumes,	2789 Bound and unbound.	
Miscellaneous Pamphlets,	570.	

DONATIONS TO THE MUSEUM.

From S. Fleming, Esq., C. E.

Large Salmon Trout from Lake Huron.

From Thomas Devine, Esq., per S. Fleming, Esq.

A Number of Electrotype (thirteen) casts of Fossils.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—OCTOBER, 1863.

Latitude—43 *deg.* 39.4 *min. North.* *Longitude*—5 *h.* 17 *m.* 33 *s. West.* *Elevation above Lake Ontario,* 108 *feet.*

Day.	Barom. at temp. of 32°. 6 A.M.	2 P.M.	10 P.M.	Mean.	Temp. of the Air. 6 A.M.	2 P.M.	10 P.M.	ME'N	Excess of mean above Normal.	Tens. of Vapour. 6 A.M.	2 P.M.	10 P.M.	M'N	Humidity of Air. 6 A.M.	2 P.M.	10 P.M.	M'N	Direction of Wind. 6 A.M.	2 P.M.	10 P.M.	Resul't. Direction.	Velocity of Wind. 6 A.M.	2 P.M.	10 P.M.	Resul't.	ME'N	Rain in inches.	Snow in inches.
					°	°	°	°	°												°							
1	29.681	29.620	29.509	29.5988	53.3	63.4	60.9	59.53	+ 9.12	.377	.404	.450	.413	.92	.69	.85	.82	N E b E	E	E N E	S 75 E	5.8	9 5	1.2	5.08	6.64	0.160	...
2	.436	.441	.537	.4753	59.1	61.2	49.7	55.52	+ 5.58	.464	.446	.267	.382	.93	83	.75	.84	S	S b E	N W b W	S 66 W	12.4	7.2	5.5	3.47	5.58	0.020	...
3	.577	.478	.372	.4593	40.7	58.0	49.7	50.58	+ 1.05	.231	.394	.298	.322	.91	.82	.83	.86	N W b W	S S E	S E	S 2 E	1.8	6.0	4.2	2.04	3.60	0.018	...
4	.371	.465	—	—	50.4	52.2	—	—	—	.299	.232	—	—	.81	.59	—	—	S W b W	S W b S	S W b W	S 46 W	7.0	20.0	9.5	11.80	11.86	0.012	...
5	.493	.564	.659	.5790	43 9	49.0	47.2	47.10	— 1.52	.226	.276	.300	.270	.79	.79	.92	.83	S W b W	W S W	W	S 70 W	10.8	12.8	7.2	7.36	7.48	0.007	...
6	.685	.693	.720	.7060	44.3	47.9	43.2	45.18	— 3.03	.248	.230	.244	.243	.86	.69	.87	.81	W b S	S S W	Calm.	S 37 W	1.8	9.0	0.0	4.02	4.10	Inp.	...
7	.717	.637	.539	.6220	42.8	45.0	49.0	45.95	— 1.90	.240	.278	.337	.284	.87	.93	.97	.91	Calm.	N E	Calm.	N 40 E	0.0	8.0	0.0	2.88	4.00	0.207	...
8	.498	.486	.562	.5187	45.4	51.5	42.8	45.97	— 1.48	.272	.256	.232	.255	.90	.68	.84	.82	N W	W N W	N W b W	N 66 W	6.8	11.0	0.5	4.74	4.84	0.005	...
9	.578	.613	.746	.6535	42.1	47.7	45.7	45.25	— 1.82	.232	.261	.268	.251	.86	.78	.87	.83	N W b W	N N E	N	N 6 E	3.0	1.8	7.5	3 60	3.85	0.043	...
10	.858	.872	.926	.8902	39.2	47.9	38.8	42.22	— 4.45	.190	.192	.186	.198	.79	.57	.79	.74	N	N E b N	N b W	N 7 W	7.0	8.0	6.6	7.70	7.86	...	...
11	.956	.913	—	—	38.8	46.1	—	—	—	.213	.263	—	—	.90	.84	—	—	N	N W	N W b N	N 20 W	5.2	10.5	2.5	4 37	4.63		...
12	.808	.742	.752	.7638	30.9	47.5	37.5	39.02	— 6.95	.141	.198	.182	.174	.81	.60	.83	.73	N b E	S b W	N	N	5.2	7.5	5.0	2.45	4.48	...	...
13	.774	.755	.727	.7508	34.2	49 3	40.7	41.80	— 3.77	.168	.231	.196	.201	.85	.65	.77	.76	N N E	E N E	N N E	N 50 E	7.0	8.2	5.5	4.08	4.87	...	...
14	.686	.615	.615	.6343	43.2	56.9	47.9	49.20	+ 3.93	.254	.351	.311	.303	.91	.76	.93	.87	N	S S W	N b E	N 39 E	0.5	2.2	3.0	0.05	1.05	Inp.	...
15	.641	.610	.563	.6063	44.3	62.7	52.2	53.18	+ 8.33	.268	.379	.337	.321	.92	.66	.86	.79	N N E	E S E	N E b N	N 53 E	0.5	0.2	3.0	2.74	3.20	Inp.	...
16	.523	.406	.339	.4130	53.6	59 8	58.0	57.25	+12.72	.384	.458	.452	.431	.93	.89	.94	.92	N E	N E b E	N E b E	N 58 E	5.2	6.4	7.0	6.81	6.85	0.305	..
17	.276	.332	.333	.3337	57.6	61.2	57.6	58.73	+14.50	.458	.486	.446	462	.96	.90	.94	.93	E N E	S b W	E S E	S 67 E	6.2	6.2	6.0	3.38	4.84	0.180	..
18	.319	.327	—	—	57.2	57.6	—	—	—	.451	.421	—	—	.96	.88	—	—	E S E	S b W	W b N	S 30 W	2.2	9.5	5.5	7.46	8.06	...	...
19	.537	.540	.597	.5605	49.0	52.2	40.7	46.82	+ 3.03	.317	.284	.204	.263	.91	.73	.80	.81	S S W	S b W	Calm.	S 17 W	5.6	6.5	0.0	3.22	4.79	...	...
20	.599	.499	.459	.5263	42.1	58.7	53.3	51.73	+ 8.17	.249	.285	.301	.282	.93	.57	.74	.74	E N E	S b E	S b W	S 34 W	3.8	11.0	1.5	5.11	8.68	...	...
21	.715	.804	.938	.8343	41.4	51.8	40.7	44 80	+ 1.55	.214	.150	.188	.183	.81	.38	.73	.63	W S W	W b N	W b N	N 81 W	7.2	12.0	3.2	8.20	8.78	...	...
22	30 009	30.014	.960	.9948	34.5	45.0	40.3	40.07	— 2.90	.166	.204	.166	.184	.83	.67	.66	.74	N W	S S E	N E b N	N 43 E	4.5	2.5	5.8	3.45	4.84	0.205	...
23	29.755	29.619	.677	.6800	39.6	41.4	38.1	39.52	— 3.23	.237	.221	.213	.222	.97	.85	.93	.92	N E b E	N W b W	N W b W	N 40 W	5.2	8.2	0.5	3.43	5.07	0.390	...
24	.840	.968	30.084	.9890	34.5	39.2	33.4	35.78	— 6.72	.181	.155	.149	.161	.90	.64	.78	.77	N W b N	N	N N E	N 4 E	4.0	11.0	2.8	6.07	6.33	...	...
25	30.162	30.192	—	—	33.1	37.1	—	—	—	.167	.146	—	—	.88	.67	—	—	N E b N	E S E	N E b N	N 48 E	8.0	3.5	3.0	4.23	4.95	...	...
26	30.197	30.145	30.098	30.1412	32.7	40.7	36.0	36.40	— 5.58	.165	.187	.162	.169	.88	.73	.76	.78	N	E	N E b N	N 55 E	4.0	5.0	3.4	3.10	4.35	...	...
27	30.121	30.085	30.056	30.0857	36.3	41.7	36.3	38.07	— 3.72	.193	.166	.151	.167	.90	.62	.71	.73	N E b N	E S E	N	N 64 E	4.0	9.5	3.8	3.64	4.85	...	...
28	30.042	30.032	29.998	30.0240	34.2	40.7	37.4	37.37	— 4.12	.160	.146	.162	.151	.81	.56	.72	.68	N b E	S E b E	E S E	S 73 E	4.5	8.0	8.0	5.82	6.52	...	...
29	29.953	29.821	.723	.8265	34.9	45.4	47.1	42.95	+ 1.68	.161	.198	.278	.216	.79	.65	.86	.77	E S E	E b S	S b E	S 37 E	2.5	9.5	13.8	8.00	9.94	...	...
30	.590	.520	.330	.4610	46.4	48.2	48.6	48.28	+ 7.33	.178	.307	.332	.316	.88	.91	.97	.93	S b E	S b E	E b S	S 8 E	13.0	9.0	7.0	8.41	9.88	0.970	...
31	.323	.687	.944	.6962	50.0	45.4	35.3	42.30	+ 1.55	.335	.119	.164	.189	.93	.38	.80	.69	S S W	W b S	W S W	S 76 W	24.5	23.2	5.8	13.72	14.07	...	...
M	29.7004	29.6888	29.6968	29.6972	42.60	50.35	44.73	45.95	+ 0.91	.252	.269	.258	.260	.88	.70	.83	.80	....	....	....	....	5.78	8.48	4.46	......	6.16	2.522	......

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR OCTOBER, 1863.

Highest Barometer . . . . . . 30.218 at 10 a.m. on 25th. } Monthly range=
Lowest Barometer . . . . . . 29.272 at midnight on 30th. } 0.946 inches.

Self-registering Ther.:
- Maximum temperature . . . 66°4 on p.m. of 1st } Monthly range=
- Minimum temperature . . . . 30°5 on a.m. of 26th } 35°9
- Mean maximum temperature . . 52°79 } Mean daily range=12°25
- Mean minimum temperature . . 40°54 }
- Greatest daily range . . . . . . 23°8 from a. m. to p. m. of 20th.
- Least daily range . . . . 6°1 from a. m. to p. m. of 2nd.

Warmest day . . . 1st...Mean Temperature . . . 59°53 } Difference=23°75.
Coldest day . . . 24th...Mean Temperature . . . 35°78 }
Maximum { Solar . . . . 83°0 on p.m. of 1st } Monthly range=
Radiation { Terrestrial . . . . 23°0 on a. m. of 25th } 60°.0
Aurora observed on 3 nights, viz., 8th, 10th, and 12th. Possible to see Aurora on 13 nights; impossible on 18 nights.
Raining on 16 days; depth, 2.522 inches; duration of fall, 65.9 hours.
Mean of cloudiness=0.64; above average, 0.03. Most cloudy hour observed, 6 a.m; mean=0.74; least cloudy hour observed, 4 p.m.; mean=0.59.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
1407.04	1523.32	1258.50	1598.35

Resultant direction, S. 71° W.; Resultant Velocity, 0.48 miles per hour.
Mean velocity 6.16 miles per hour.
Maximum velocity 29.4 miles, from 11 a.m. to noon on 31st.
Most windy day 31st—Mean velocity 14.07 miles per hour. } Difference 13.02.
Least windy day 14th—Mean velocity 1.05 miles per hour. }
Most windy hour, noon to 1 p.m.—Mean velocity, 8.87 miles per hour. } Difference
Least windy hour, 10 to 11 p.m.—Mean velocity, 4.51 miles per hour. } 4.36 miles.

3rd. Hoar frost and thin ice at 6 a.m.; sheet lightning 8.30 to 10 p.m. and midnight. —6th. Particles of hail falling at 2 p.m.—7th. Fog at 10 p.m. and midnight.—8th. Auroral light and streamers in N. N. E. and N. W. at 10 p.m. and midnight.—10th. Bright auroral light and some fine streamers in N. at 9 p.m.—12th. Hoar frost and thin ice 6 a.m.; auroral light, arches and streamers, 9 p.m. to midnight.—13th. Sharp hoar frost 6 a.m.—14th. Fog and heavy dew 8 p.m. to midnight.—15th. Fog and heavy dew 6 a.m.; sheet lightning 7.30 p.m. —16th. Distinct solar halo 3 to 4 pm.—17th. Fog at 6 a.m.—22nd. Hoar frost 6 a.m.—24th, 25th, and 26th. Thin ice at 6 a.m.—26th. Faint lunar halo during the evening; particles of hail at 4.30 p.m.—29th. Solar halo 2 p.m.; lunar halo at midnight.

Heavy dew recorded on 4 mornings during this month.
October, 1863, was comparatively mild, windy and cloudy. The depth of rain recorded was above the average; but as there was no appreciable depth of snow, the total amount of moisture fell below the average.

COMPARATIVE TABLE FOR OCTOBER.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above Average, (45°5).	Maximum observed.	Minimum observed.	Range.	No. of days.	Inches.	No. of days.	Inches.	Resultant. Direction.	Resultant. Velocity.	Mean Force or Velocity
1840	° 44.4	— 1.1	° 68.5	° 23.9	° 44.6	13	1.860	3	...	...	...	...
1841	41.6	— 3.9	58.3	20.3	38.0	6	1.360	2	...	...	...	0.41 lbs
1842	45.1	— 0.4	68.5	30.0	38.5	8	5.175	0	...	...	...	0.35 "
1843	41.8	— 3.7	65.7	24.5	41.2	12	3.790	4	2.5	...	...	0.54 "
1844	43.3	— 2.2	69.6	17.8	51.8	7	Imp.	4	12.0	...	...	0.43 "
1845	46.4	+ 0.9	62.7	20.0	42.7	11	1.760	1	Inp.	...	...	0.26 "
1846	44.6	— 0.9	69.7	20.7	49.0	14	4.180	2	Inp.	...	...	0.44 "
1847	44.0	— 1.5	65.0	20.3	44.7	13	4.390	2	Inp.	...	...	0.19 "
1848	46.3	+ 0.8	62.2	26.4	35.8	11	1.550	0	0.0	N 54 W	1.24	4.60 ms
1849	45.3	— 0.2	59.2	25.5	33.7	13	5.965	1	Inp.	N 12 W	1.27	7.76 "
1850	45.4	— 0.1	66.6	24.8	41.8	10	2.085	0	0.0	N 66 W	1.10	5.30 "
1851	47.4	+ 1.9	66.1	25.0	41.1	10	1.680	2	0.3	S 72 W	1.06	4.39 "
1852	48.0	+ 2.5	70.7	29.8	40.9	12	5.280	0	0.0	N 5 E	1.19	4.47 "
1853	44.4	— 1.1	64.7	25.5	39.2	10	0.875	2	Inp	S 88 W	1.74	4.77 "
1854	49.5	+ 4.0	74.2	29.8	44.4	15	1.495	3	Inp.	N 45 W	1.52	4.57 "
1855	45.4	— 0.1	64.3	28.0	36.3	14	2.485	5	0.8	N 82 W	4.91	9.88 "
1856	45.3	— 0.2	70.1	23.3	46.8	10	0.875	2	0.1	N 76 W	2.15	6.07 "
1857	45.4	— 0.1	63.5	27.7	35.8	10	1.040	2	0.2	N 19 W	2.93	6.24 "
1858	48.8	+ 3.3	76.3	34.2	42.1	17	1.797	1	Inp.	N 34 W	0.36	5.96 "
1859	43.0	— 2.5	68.4	22.3	46.1	11	0.940	4	Inp.	N 68 W	5.04	8.12 "
1860	47.3	+ 1.8	63.7	28.4	35.3	15	1.618	1	Inp.	N 9 W	2.00	6.93 "
1861	48.7	+ 3.2	64.5	30.2	34.3	15	1.993	1	Inp.	N 61 W	1.06	5.96 "
1862	48.7	+ 3.2	76.0	27.0	49.0	19	2.684	2	0.5	N 78 W	2.89	6.53 "
1863	45.9	+ 0.4	63.4	30.9	32.5	16	2.522	0	0.0	S 71 W	0.48	6.16 "
Results to 1861.	45.52	...	66.48	25.38	41.10	11.7	2.485	1.9	0.84	N 56 W	1.67	5.86
Exc. for 1863.	+0.43	...	— 3.08	+ 5.52	— 8.60	+ 4.3	+ 0.037	— 1.9	— 0.84	...	...	+ 0.30

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—NOVEMBER, 1863.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 min. 33 sec. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resultant Direction.	Velocity of Wind.					Rain in Inches.	Snow in Inches.
	6 A.M.	2 P.M.	10 P.M.	MEAN.	6 A.M	2 P.M.	10 PM	ME'N		6 A.M	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N	6 A.M.	2 P.M.	10 P.M.		6 A.M	2 P.M	10 PM	Re-sul't.	ME'N		
					°	°	°	°	°												°							
1	30.050	30.074	—	—	32.4	39.6	—	—	—	.169	.168	—	—	.91	.99	—	—	W	N N W	E b N	N 81 E	0.5	2.5	2.0	3.28	4.77	...	...
2	29.920	29.674	29.491	29.6955	38.8	44.3	47.1	43.28	+ 3.02	.186	.203	.299	.231	.79	.69	.92	.81	E b S	E b S	S E b E	S 57 E	15.5	12.2	1.2	3.08	8.98	0.647	...
3	.588	.667	.788	.7042	45.0	45.0	35.6	41.57	+ 1.57	.204	.185	.159	.183	.67	.62	.76	.69	W	W b N	W	W	20.0	16.0	3.2	10.32	10.37	...	...
4	.858	.782	.577	.7205	32.7	50.0	46.4	43.23	+ 3.47	.135	.232	.221	.204	.73	.63	.70	.72	W S W	S b W	E N E	S 19 E	4.0	9.0	6.0	3.66	6.58	0.355	...
5	.182	.237	.374	.2735	46.8	57.6	45.0	50.15	+10.67	.295	.310	.239	.281	.92	.64	.80	.77	E	W	W b S	S 85 W	4.0	24.5	1.2	10.69	12.12		...
6	.334	.461	.558	.4627	43.5	42.1	33.4	39.43	+ 0.27	.223	.194	.171	.194	.78	.72	.89	.79	W S W	W N W	W b S	N 76 W	1.2	26.5	5.2	9.59	9.85	0.180	...
7	.469	.337	.452	.4253	37.8	40.3	37.8	38.50	— 0.50	.208	.236	.217	.220	.91	.95	.96	.94	W N W	N E b E	N b E	N 9 E	5.0	4.4	1.6	2.27	4.46	0.250	...
8	.614	.708	—	—	34.9	35.6	—	—	—	.186	.177	—	—	.92	.85	—	—	W N W	N W b N	N	N 24 W	8.0	11.2	2.5	7.69	7.82	...	Inp.
9	.793	.794	.875	.8333	26.6	34.5	29.8	30.60	— 7.80	.126	.122	.125	.126	.87	.60	.75	.74	N b W	N W b N	N b E	N 28 W	2.5	7.0	3.2	6.60	7.00	...	..
10	.938	.898	.764	.8535	25.2	33.8	30.6	30.17	— 7.92	.122	.115	.138	.129	.90	.58	.80	.77	N W b N	W b N	S W	S 79 W	12.4	9.2	11.3	8.03	9.88	...	Inp.
11	.535	.329	.392	.4128	36.3	46.4	43.9	42.03	+ 4.25	.176	.249	.190	.204	.92	.79	.66	.76	S W	W S W	S W b W	S 53 W	10.8	18.0	11.2	11.45	11.69	..	...
12	.399	.453	.476	.4535	40.3	50.0	38.9	42.57	+ 5.07	.219	.283	.203	.230	.87	.78	.86	.84	W b S	S W b S	Calm.	S 40 W	1.2	5.0	0.0	1.18	1.25	...	...
13	.478	.504	.568	.5212	37.1	41.7	38.9	39.40	+ 2.22	.200	.222	.203	.213	.90	.84	.86	.88	N N E	E N E	E b N	N 76 E	1.8	8.8	10.5	9.32	9.46	0.095	...
14	.472	.303	.340	.3715	37.4	45.0	47.9	43.87	+ 6.97	.196	.269	.311	.265	.87	.90	.93	.91	E	N E b E	Calm.	N 74 E	12.4	11.2	0.0	4.94	6.33	0.242	...
15	.426	.373	—	—	43.9	48.2	—	—	—	.273	.307	—	—	.95	.91	—	—	Calm.	N E b N	N N E	N 15 E	0.0	7.8	10.0	5.72	6.05	0.405	...
16	.496	.561	.623	.5663	45.0	43.2	41.7	43.25	+ 7.05	.298	.262	.255	.271	.99	.94	.96	.96	N E b N	S	Calm.	N 82 E	0.5	3.8	0.0	1.23	1.84	0.070	...
17	.578	.464	.301	.4377	39.9	47.5	44.6	44.18	+ 8.38	.241	.216	.235	.233	.98	.65	.80	.81	N	N N W	N W	N 52 W	0.8	11.4	19.8	12.94	13.43	...	...
18	.248	.227	.249	.2423	43.5	46.8	41.7	43.53	+ 8.05	.214	.217	.218	.218	.75	.67	.82	.76	W	W S W	S W b W	S 57 W	20.5	10.2	1.5	5.80	5.97	...	...
19	.353	.322	.296	.3248	41.0	50.8	50.0	46.97	+11.88	.237	.273	.295	.267	.92	.73	.81	.82	S W b S	S S W	S S W	S 45 W	1.4	15.0	6.8	8.03	9.52	Inp.	...
20	.393	.481	.650	.5198	41.0	43.9	33.1	39.22	+ 4.45	.192	.208	.153	.189	.75	.72	.81	.78	W b N	W b S	W S W	S 76 W	19.0	14.0	1.3	7.31	7.39	...	...
21	.634	.474	.499	.5410	28.7	39.9	33.8	34.68	+ 0.30	.138	.190	.182	.173	.87	.77	.93	.85	Calm.	E N E	W b S	S 47 W	0.0	5.0	3.5	1.90	3.69	...	...
22	.768	.916	—	—	32.7	37.8	—	—	—	.150	.114	—	—	.80	.50	—	—	S W b W	W	Calm	S 82 W	8.0	16.0	0.0	6.36	6.58	...	...
23	30.162	30.144	.937	30.0597	30.9	38.5	37.8	35.43	+ 1.77	.120	.163	.157	.147	.69	.70	.69	.71	N W	E	E	N 74 E	0.2	5.0	7.0	5.55	5.78	0.230	...
24	29.682	29.268	.202	29.3760	35.6	41.0	42.8	39.68	+ 6.42	.202	.246	.169	.206	.97	.95	.61	.84	E N E	E b S	W b S	S 57 W	11.0	10.0	21.4	5.30	14.72	0.532	...
25	.486	.516	.628	.5583	34.5	36.3	29.8	33.37	+ 0.40	.148	.125	.125	.129	.74	.59	.75	.68	W b N	W	W b S	N 87 W	10.8	7.0	3.0	7.58	7.91	...	Inp.
26	688	.742	.753	.7297	29.1	38.5	35.6	34.22	+ 1.65	.141	.140	.149	.145	.87	.60	.72	.74	W S W	S W b W	W S W	S 56 W	2.8	10.3	5.2	6.01	6.06	...	...
27	.770	.650	.544	.6435	30.9	45.0	37.4	38.92	+ 6.73	.149	.221	.196	.201	.86	.74	.87	.84	W S W	S b W	Calm.	S 17 W	1.0	7.0	0.0	3.83	4.03	0.510	...
28	.376	.210	.411	.3448	41.4	42.8	30.2	37.35	+ 5.47	.250	.232	.136	.203	.95	.84	.80	.87	S b W	Calm.	N W b W	N 62 W	8.0	0.0	18.5	11.26	13.35	0.140	Inp.
29	.595	.640	—	—	24.1	26.2	—	—	—	.100	.124	—	—	.77	.87	—	—	W N W	W	N E	N 41 W	11.2	4.0	0.2	4.32	5.37	...	0.1
30	.751	.773	.898	.8202	21.5	25.7	23.0	22.72	— 8.37	.082	.099	.106	.093	.71	.70	.86	.76	W	W b S	W S W	S 73 W	14.5	25.0	8.0	13.53	13.65	...	Inp.
...	......	......	......	......	......	......	......	......	......	......	......	......	......	....	....	....	....	......	......	......	......	......	......	......	......	......	......	...
M	29.5833	29.5308	29.5458	29.5537	36.42	42.82	38.27	39.13	+ 2.98	.188	.208	.194	.198	.84	.73	.81	.80	......	......	......	......	6.97	10.57	5.51	......	7.86	3.656	0.1

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR NOVEMBER. 1863,

NOTE.—The monthly means do not include Sunday observations. The daily means, excepting those that relate to the wind, are derived from six observations daily, namely at 6 A.M., 8 A.M., 2, 4 and 10 P.M., and midnight. The means and resultants for the wind are from hourly observations.

Highest Barometer.........................30.181 at 8 a.m. on 23rd } Monthly range =
Lowest Barometer ....29.096 at 7 p. m. on 24th } 1.085 inches.

Self-registing Thermom.
- Maximum Temperature .... 67°0 on p.m. of 5th } Monthly range=
- Minimum Temperature .... 17°8 on a.m. of 30th } 49°2
- Mean maximum Temperature .... 44°82 } Mean daily range=
- Mean minimum Temperature .... 33°34 } 11°49
- Greatest daily range ......23°0 from a.m. to p.m. of 5th.
- Least daily range............ 3°3 from a.m. to p.m. of 16th.

Warmest day .... 5th... Mean temperature......... 50°15 } Difference = 27°43.
Coldest day .... 30th... Mean temperature......... 22°72 }
Maximum { Solar...................................... 79°0 on p.m. of 5th } Monthly range =
Radiation. { Terrestrial.............................. 7°4 on a.m. of 30th } 71°6
Aurora observed on 1 night, viz.,—on 1st.
Possible to see Aurora on 10 nights; impossible on 20 nights.
Snowing on 6 days, depth 0.1 inches; duration of fall, 10.9 hours.
Raining on 13 days, depth 3.656 inches; duration of fall 93.8 hours.
Mean of cloudiness = 0.71; below average 0.03.
Most cloudy hour observed, 4 p.m; mean = 0.78; least cloudy hour observed, 6 a.m.; mean, = 0.65.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
1359.76	1274.06	991.83	3502.44

Resultant direction N. 88° W.; Resultant velocity 3.50 miles per hour.
Mean velocity ....7.86 miles per hour.
Maximum velocity .... 33.0 miles, from noon to 1 p.m. on 5th.
Most windy day ......24th..............Mean velocity, 14.72 miles per hour. } Difference=
Least windy day ...12th...............Mean velocity, 1.25 ditto. } 13.47 miles.
Most windy hour .... 1 to 2 p.m..................Mean velocity, 11.07 ditto. } Difference=
Least windy hour ...8 p.m. to 9 p.m..........Mean velocity 5.83 ditto. } 5.24 miles.

1st. Faint auroral light at 9 p.m.—5th. Fog at 6 a.m.; very mild day; wind in warm gusts.—6th. Showers of rain and hail during the forenoon.—8th. Particles of snow 3 to 6 p.m., and from 8 to 9.30 p.m.—9th. Brilliant Meteor in N at 7.40 p.m.—10th. Particles of Snow 0.30 to 2 p.m.—11th. Faint Solar Halo at 2 p.m.—13th. Fog at 6 a.m.; Solar Halo at 1 p.m.—19th. Fog at 6 and 8 a.m.—21st. Fog at 8 a.m.—23rd. Spray rising from Niagara Falls distinctly visible.—24th. Dense fog 2 to 6 p.m., Wind in violent squalls at night.—25th. Particles of Snow during forenoon; Lunar Corona at midnight.—27th. Faint Solar Halo at noon.

November, 1863, was comparatively mild, wet, windy, and clear.

COMPARATIVE TABLE FOR NOVEMBER.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above aver'ge (36.7)	Max. ob-served.	Min. ob-served.	Range.	No. of days.	Inches	No. of days.	Inches	Resultant. Direction.	Resultant. V'y.	Mean Force or Velocity.
1840	° 35.9	° — 0.8	° 54.4	° 20.5	° 33.9	5	1.220	8	...	...	...	....
1841	35.0	— 1.7	63.2	7.6	55.6	8	2.450	5	...	...	...	0.91 lbs.
1842	33.3	— 3.4	50.6	7.6	43.0	9	5.310	10	...	...	...	1.22
1843	33.5	— 3.2	51.2	14.4	36.8	10	4.765	7	1.2	...	...	0.59
1844	34.9	— 1.8	49.8	12.0	37.8	8	Imp.	4	8.0	...	...	0.48
1845	36.8	+ 0.1	58.8	7.6	51.2	7	1.105	4	5 0	...	...	0.53
1846	41.3	+ 4.6	55.5	18.2	37.3	12	5.805	2	0.4	...	...	0.64
1847	38.6	+ 1.9	48.2	7.8	50.4	14	3.155	3	Inp.	...	...	0.36
1848	34.5	— 2.2	49.3	16.5	32.8	9	2.020	3	1.4	N 81° W	1.81	4.81 mls.
1849	42.6	+ 5.9	56.7	28.4	28.3	10	2.815	2	1.0	N 39° W	1.55	4.78
1850	38.8	+ 2.1	62.3	18.1	44.2	7	2.955	1	Inp.	N 42° W	1.43	5.27
1851	32.9	— 3.8	50.1	16.5	33.6	5	3.885	6	6.7	N 50° W	1.25	4.70
1852	36.0	— 0.7	50.4	18.7	31.7	7	1.775	3	2.0	N 59° W	1.53	6.50
1853	38.7	+ 2.0	54.1	14.4	39.7	15	2.425	6	2.7	N 9° W	0.55	5 52
1854	36.8	+ 0.1	54.9	15.1	39.8	13	1.115	4	1.3	W	3.44	7 54
1855	38.6	+ 1.9	54.1	18.7	35.4	8	4.590	6	3.0	N 66° W	3.18	10.81
1856	37.4	+ 0.7	56.4	22.8	33.6	10	1.375	9	9.5	S 85° W	2.95	8.75
1857	33.5	— 3.2	57.8	—2.3	60.1	14	3.235	9	6.9	S 61° W	5.45	9.25
1858	34.2	— 2.5	52.0	20.5	31.5	12	3.879	13	4.0	N 25° W	3.14	8.87
1859	38.9	+ 2.2	61.0	24.1	36.9	12	5.193	9	0.6	N 81° W	3.39	9.65
1860	37.9	+ 1.2	62.7	14.0	48.7	12	2.569	8	1.9	S 89° W	4.95	11.02
1861	37.1	+ 0.4	51.5	25 1	26.4	14	4.294	8	3.2	N 46° W	1.94	7.44
1862	35.6	— 1.1	58.0	17.2	40.8	11	2.205	11	5 3	N 46° W	3.00	6.60
1863	39.1	+ 2.4	57.6	19.4	38.2	13	3.656	6	0.1	N 88° W	3.50	7.86
Results to 1861.	36.69	...	55.23	15.74	39.49	10.0	3.140	5.9	3.10	N 76° W	2.29	7.49
Exc. for 1863.	+ 2.44	...	+ 2.37	+ 3.66	— 1.29	+ 3.0	+ 0.516	+ 0.1	— 3.00	....	......	+ 0.37

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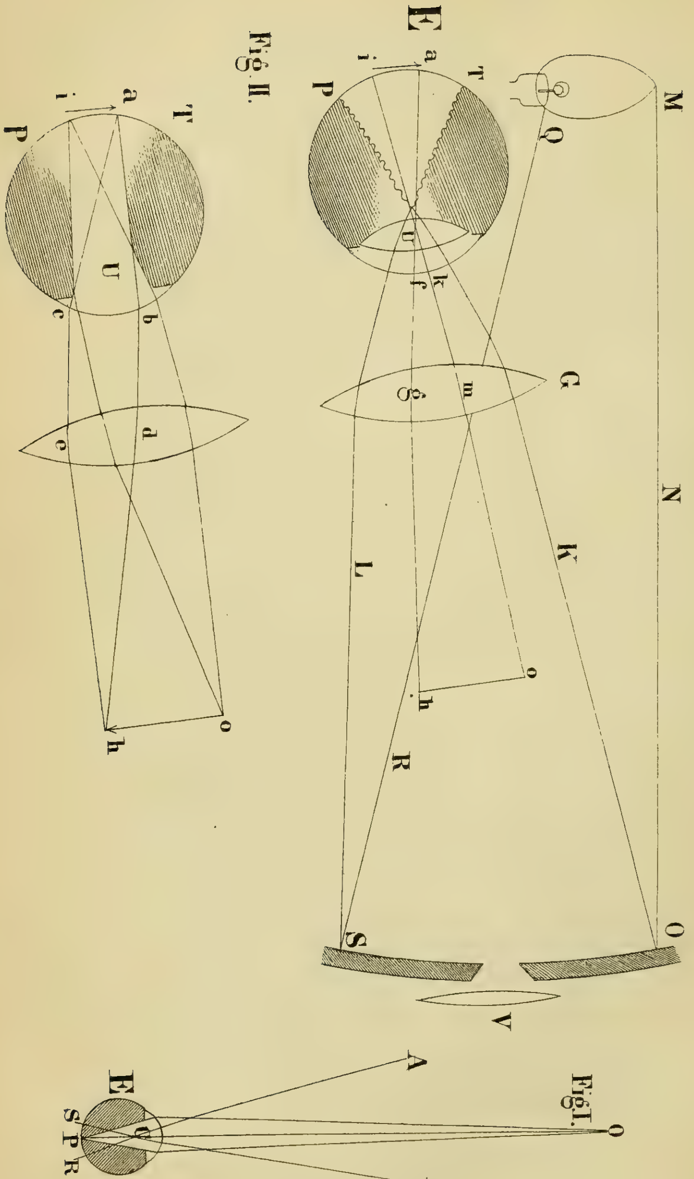

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THE CANADIAN JOURNAL.

NEW SERIES.

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A NEW OPHTHALMOSCOPE FOR PHOTOGRAPHING THE POSTERIOR INTERNAL SURFACE OF THE LIVING EYE; WITH AN OUTLINE OF THE THEORY OF THE ORDINARY OPHTHALMOSCOPE.

BY A. M. ROSEBRUGH, M.D.

Read before the Canadian Institute, January 16th, 1864.

Before entering upon the construction and mode of using this Instrument I propose :

(1.) Dwelling briefly upon the optics of the eye, glancing at the cause of the blackness of the pupil under ordinary circumstances and the invisibility of the parts behind it, and

(2.) Giving an outline of the optics involved in the ordinary Ophthalmoscope.

In order to make the subject as plain as possible, I have at the outset summed up the leading optical principles involved, and that they may be more readily referred to, I have arranged them in the form of *Definitions*—(1), Rays of light incident upon highly polished plate glass with parallel surfaces, are partly reflected and partly refracted. If the plate glass is thin, the rays that are not reflected may practically be considered to pass through the glass unrefracted.

(2.) There is a point in every double convex lens called the optical centre, rays of light passing through which are either unrefracted or are refracted parallel to their original direction.

(3.) Parallel rays of light, incident upon a convex lens, are so refracted that they leave the second surface of the lens convergingly and meet in a focus at the principal focus of the lens.

(4.) Conversely if rays of light diverge from a focus at the principal focus of the lens, the corresponding refracted rays will be parallel.

(5.) When diverging rays of light are incident upon a double convex lens, and radiate from a point beyond its principal focus, the corresponding refracted rays are brought to a focus on the opposite side of the lens and at a point further from the lens than the principal focus.

(6.) Converging rays under the same circumstances form a focus at a point between the lens and its principal focus.

(7.) As I shall have occasion to use the word *Camera* in this paper, I will here state that I refer to the instrument used in Photographing, which consists of a darkened box, to one end of which is adapted a tube containing one or more convex lenses of such strength that the principal focus is within the box. Objects in front of the lens will form an inverted image in the box which is usually received upon a screen of ground glass near the back of the *camera*. The eye of an observer in rear of the *camera* (and not nearer than eight inches from the ground glass,) sees this inverted image distinctly depicted upon the ground glass.

(8.) If the ground glass is removed, an aerial image is seen to occupy the position from which the ground glass was just removed.

The dioptric media of the eye are made up of the cornea, aqueous humor, crystalline lens, and vitreous humor, all differing in density and consequently in their refractive power, but the effects produced by their combination resemble those produced by a double convex lens, or a single spherical refracting surface, having its convexity towards the less refracting medium. Like a double convex lens, it too has an optical centre, any ray passing through which is either unrefracted or refracted parallel to its original direction, thus :—

Let E (Fig. I.) represent a section of an eye, and C its optical centre; any ray as AE passing through C will pass on to the retina unrefracted, or at least parallel to its original direction.

The position of the optical centre varies according to the focal adjustment of the eye, being further from the retina, when the eye is adjusted for near objects, than it is when adjusted for distant objects.

Its mean distance is considered to be near the centre of the crystalline lens.

For the sake of simplicity, in the accompanying diagrams, I have represented the eye as a homogenous body, possessed of a single condensing, refracting surface, which may be regarded as the optical equivalent of the various surfaces in a real eye, and may be considered sufficiently accurate for any optical conclusions involved in the present paper.*

It is well known that under ordinary circumstances the pupil of the eye appears to be perfectly black, and that all parts behind it are perfectly invisible; this was formerly thought to depend on the complete absorption of all the rays of light that fall upon the fundus or posterior internal surface of the eye, so that none of them passed out again from its interior.

That this is not the case can very easily be demonstrated by a simple experiment suggested by Wharton Jones:—"Having previously dilated the pupil of a cat's eye by a solution of Atropine or Belladonna, drop some water into the eye while the eyelids are held apart, and cover the cornea with a thin plate of glass. The optic nerve entrance and the vessels of the retina can then be distinctly seen slightly magnified."

In this experiment we in reality neutralize the refracting condensing power of the convex surface of the cornea. Here it will be seen that the water, filling up the space between the cornea and the piece of glass, forms a perfect concave lens with its concavity applied to the *cornea*, thus changing the *convex* to a plane surface. From this it is evident that as the fundus of the eye comes in view, when its refractive power is to a certain extent neutralized, therefore the blackness of the pupil and the invisibility of the parts behind it depend solely upon the refraction of the light by the ocular media.

This phenomenon of refraction may be demonstrated with any small camera obscura by simply placing a piece of pasteboard behind the ground glass so as to exclude all light from the camera except what reaches it through the lens; the ground glass being in focus, distinct images of objects in front of the lens are formed on its surface, notwithstanding which, the interior of the *camera* when viewed through the lens appears absolutely black.

* The same mode of representation has been adopted by Stellway von Carion, Vienna, and by G. Rainy, M.D., Glasgow.

In the camera obscura we have an imitation of the eye, its ground glass screen representing the retina, and its lens—the cornea and lens of the eye.

If we remove the lens the back of the camera immediately becomes visible.

This phenomenon then can only be explained by the laws of refraction.

"When a properly formed eye is exactly accomodated for a luminous object, the diverging rays from this incident upon the eye are refracted by the ocular media in such a manner that they unite at a point in the surface of the retina which is the image of that object. The retina in conseqnence of its transparency transmits much of this light to the *choroid*, by which most of it is absorbed; bnt many of these rays are reflected in the same direction in which they entered the eye and return to the object whence they started. The object, then, and its image on the retina are reciprocal points (they may be considered conjugate foci) each being in turn object or image."* Thus, let E (fig. I.) represent an eye accommodated for the object O. In this case the diverging rays from O, falling upon the cornea of the eye E, are refracted by the media of the eye and collected at P, a point in the retina of E. This point, P, in E's retina, is the image of the object O; and since the rays, when reflected from the eye, simply retrace their steps, the rays from the retina at P will return only to the object O. These reflected returning rays cannot therefore meet the eye of a person at A, but the pupil of E will appear black. And, if the observer's eye be placed in the line OE the illuminating rays will be intercepted. From this it is apparent that without some special contrivance, one person cannot bring his eye into the direction of the rays returning from the eye under examination, without at the same time intercepting the incident rays. *This is effected by substituting reflected for direct light*, the observer placing his eye behind and looking through the mirror into the illuminated eye. This is the principle upon which is constructed the Ophthalmoscope which was invented in 1851 by Helmholtz, a German physiologist, but we are indebted to Liebreich, also a German, for the convenient little instrument now in general use by Ophthalmoscopists. This Ophthalmoscope, the theory of which is illustrated in fig. II., consists of a metallic mirror 1¼ inches in diameter and of about 6 inches focal length, pierced by a

* Hulke, Treatise on the Ophthalmoscope.

central sight hole the diameter of which is about $\frac{1}{6}$ of an inch. Let E (fig. II.) represent the eye under examination, and U its optical centre, NR are diverging rays from MQ a flame, falling upon the mirror OS which reflects them convergingly as KL towards the eye E. At a short distance from the eye the rays are intercepted by G a bi-convex lens of 2-inch focal length, which so increases their convergence that they form a focus near the optical centre and again diverge and illuminate a large portion of the fundus of the eye as at TP.

The pencils of light from any point in the retina, as *a*, fig. II., pass from the cornea, very nearly parallel* and meeting the bi-convex lens G they converge to a focus at the principal focal length of the lens, (see definition 3) at 2 inches where they form an enlarged and inverted image, which, with the rays from I, form an aerial (def. 7) image of the fundus of the eye visible to an observer's eye looking through the sight hole of the mirror OS. This aerial image may again be enlarged by placing a convex lens V in the clip which is adapted to the back of the mirror.†

In the combination which I have arranged I have succeeded in being able to receive this aerial image upon a screen of ground glass, and by substituting a "sensitized" plate for the ground glass, I have succeeded in being able to demonstrate that photographs can be taken showing the details of the fundus of the eye.

This instrument consists of a small photographic camera, to which are adapted two brass tubes (A and B) which meet each other at right angles (fig. 1), $1\frac{1}{2}$ inches in diameter, being respectively 4 and $2\frac{1}{2}$ inches in length. The longer tube B moves freely in the aperture of the camera and the shorter tube A is turned towards the source of light.

A tube of the same width C, $1\frac{1}{2}$ inches in length is joined to the side of the outer extremity of the tube B, opposite to and in a line with the tube A. The outer extremity of the tube B extends $\frac{1}{4}$ of an inch beyond its juncture with the tubes A and C, and is termi-

* When the accommodation of the eye is paralyzed by a strong solution of Atropine the eye is adjusted for parallel rays, or rays that are very slightly convergent.

† There is another mode of examining the fundus of the eye, with this instrument, called the direct method. The mirror and eye of the observer are brought within one or two inches of the eye under examination. If the eye under examination is a normal eye and has its accommodation paralized by Atropine, the rays of light that are reflected from the eye are parallel, and are brought to a focus on the retina of the observed eye if its refractive media are normal. But if either eye is myopic a concave lens is placed in the clip at the back of the mirror in order to give the reflected rays the necessary parallelism or divergence.

nated by a thin brass diaphragm having a central circular aperture of $\frac{3}{8}$ of an inch in diameter.

CONSTRUCTION :—THE TUBES.

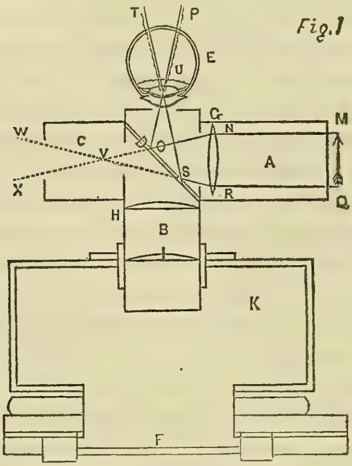


FIG. 1.

At the juncture of the tube A with B there is a circular aperture of one inch diameter, and between C and B an aperture of $\frac{1}{2}$ inch diameter—affording a communication between A and C through B.

THE PLATE GLASS.

At the juncture of the tubes there is placed an elliptical piece of highly polished thin plate glass with parallel surfaces, which is inclined at such an angle to the tubes that a portion of a ray of light falling upon it through the centre of the tube A from the direction M Q is reflected at right angles to its original direction, and in the same plane with the centre of the tube B which will be through the centre of the aperture in the diaphragm. A portion of the ray will be refracted by the plate glass and pass through the tube C parallel to its original direction.

THE LENSES.

At the inner extremity of the tube A and as close as possible to its juncture with the tube B, a double convex lens G is placed $1\frac{1}{4}$

inches in diameter, and having a focus of $2\frac{1}{2}$ inches. In the corresponding position of the tube B, or close to the plate glass reflector, the lens H is placed convexo-plane, of 5 inch focal length : $1\frac{2}{3}$ inches from this is another lens also convexo-plane, and having a focal length of 5 inches, and having the same diameter, viz : $1\frac{1}{4}$ inches.

THE CAMERA.

The camera consists of a mahogany box 3 inches square and 7 inches high, having (to secure steadiness) a base 6 inches square.

At the aperture in the centre of the anterior side there is a brass collar fitted, through which slides the tube containing the lenses. At the opposite side of the camera is a central aperture $2\frac{1}{2}$ inches square, behind which is a slide with a piece of ground glass $2\frac{1}{2}$ inches square. This slide moves in grooves for the purpose, and can be removed to make way for a slide containing a sensitized plate also about $2\frac{1}{2}$ inches square.

PHOTOGRAPHING.

As yet I have not attempted a photograph of the retina of the human eye, but have confined my experiments to the lower animals, and I have used solar light only in order to shorten the time as much as possible, but I do not doubt that diffused light, particularly that reflected from a bright cloud, would, with a longer "exposure," answer very well. In using the instrument for this purpose, a table of the ordinary height is placed near a window where the light of the sun falls upon it. It is well to have the shutters closed, and a beam of solar light admitted of the size of the illuminating tube, but this is not absolutely necessary, if precautions are taken to prevent diffused light entering the camera, and the ground glass is shaded while examining the image on its surface.

The camera is turned at right angles to the source of light, and the tube A or illuminating tube turned so that the light falls full into the tube, and is incident upon the whole of the lens G.

When the camera and tube are in proper position, a cone of light issues from the end of the camera tube through the centre of the aperture in the diaphragm, which is the condensed light from the lens G, reflected from the plate glass D. This cone forms a focus about $\frac{1}{2}$ inch outside the diaphragm which can be seen by holding a thin piece of white paper near the diaphragm. In photographing

the eye of a cat, I found it necessary to put it under the influence of chloroform, but the image of the optic nerve, vessels, &c., upon the ground glass is so very bright and clear that I do not doubt if the most sensitive process be adopted, the impression could be taken instantaneously, thus rendering anesthesia unnecessary.

POSITION.

In either case the eye is brought to the proper position, and the eye-lids held apart by an assistant. If it is the eye of a patient to be photographed the instrument is mounted upon its case, 8 inches high, which, for most persons, gives it the right height. The patient being seated upon a chair, as close as possible to the table, leans forward towards the camera, and brings his eye as near as possible to the aperture in the diaphragm, the brow rests lightly against the end of the tube, and by bringing the elbow upon the table he, with the palms of his hands, extemporizes a very good rest for his chin.

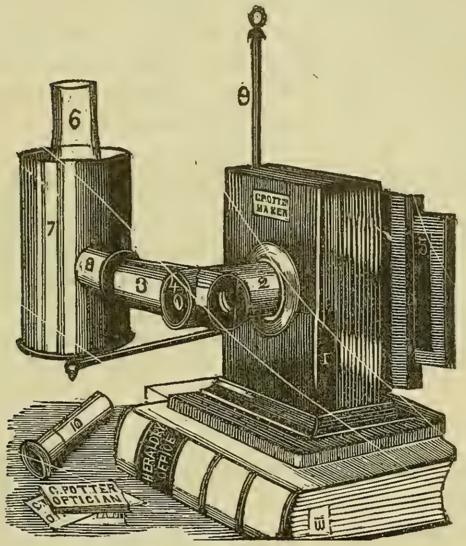
The pupil of the eye to be photographed must be previously dilated with atropine.

PROCESS.

When the instrument is in its proper position, and the light from the plate glass enters the dilated pupil, the fundus of the eye is brilliantly illuminated, and its reflection passes out of the eye and through the plate glass and lenses, and forms an inverted image upon the ground glass at the back of the camera, where the observer in the rear can see the optic nerve entrance, distribution of the arteries and veins, &c., beautifully depicted, but magnified about 4 diameters. If the details of the image are not perfectly defined the camera tube is moved backward and forward until the proper focus is obtained. This image can be seen by the observer again very much magnified by placing to his eye a lens of say 6 inch focal length, and bringing his eye with the lens to within 6 inches of the ground glass, but the image will be seen even better by moving the ground glass to one side—the observer will then see the *aërial* image of the reflection from the eye which will occupy the same position as the ground glass previously occupied, (see Definition 8). In photographing, the slide containing the ground glass is removed and a slide substituted containing a plate glass "prepared" by the ordinary collodion process. An "exposure" of about 5 seconds is sufficient. If the

"developing" proves that a good "negative" has been obtained, it is "fixed," and used for printing the photographs; if not, other plates are used until a more satisfactory result is obtained.

AS AN OPHTHALMOSCOPE.



The position of the instrument when the light is supplied by a lamp:—1 the camera, 2 camera tube, 3 illuminating tube, 4 diaphragm with central aperture, 5 slide with ground glass, 6 glass chimney of lamp, 7 brass tube four inches in diameter which acts as a shade and from which projects 8 a brass collar opposite the flame of the lamp and to which is adapted 3 the illuminating tube of the instrument, 9 upright of the lamp stand, 10 eye-piece containing a camera lens of three inch focus to be adapted to the free extremity of the camera tube, when the eye-piece is used the camera is dispensed with.

In using this instrument as an ophthalmoscope, that is, for examining the interior of the eye, artificial light is used. The light from a kerosine oil lamp answers very well, but the best light for ophthalmoscopic purposes is from the gas-argand-burner, and the most convenient is the moveable table lamp, supplied with gas through a flexible tube. The evening is the best time for making these examinations ; if in the day time, the room is darkened. The instrument is placed in the same position in regard to the light as when solar light is used, but the flame of the lamp is brought within 2 or 3 inches of the entrance of the illuminating tube, and the two are placed on the

same horizontal line. A screen, to shade the ground glass and the observer's eyes, is placed between the light and the back of the camera; or what I have found to be much better, a metallic tube or shade is placed around the lamp, from an aperture in which, projects a collar somewhat resembling that of a magic lantern, of the right size to allow the illuminating tube of the instrument to fit closely. Indeed with this apparatus the camera can be dispensed with, that is, in making examinations of the eye simply, but when the object is to demonstrate the fundus of the eye to a number of persons the camera is used both with and without the ground glass.

Since this paper was read before the Institute, Mr. Potter has constructed for me a modification of the above instrument which I find to be very convenient.

It shews the fundus of the eye of the cat or dog beautifully, but it remains to be seen whether the illumination is sufficient for examining the fundus of the human eye.

The light is supplied by an ordinary coal oil lamp which is placed in a box about six inches square and fifteen inches high. Opposite the flame of the lamp there is an aperture in one side of the box from which projects a brass tube or collar to which is adjusted the illuminating tube of the instrument.

In the outer or camera tube is a double convex lens of 2 inch focus instead of the two lenses of 5 inch focus each. At the outer extremity of this tube a moveable eye piece is attached three inches in length, and containing a convex lens of three inch focus.

OPTICS.

1st. *Illumination*:—Let MQ (fig. 1) represent parallel rays of solar light incident upon the double convex lens G: at the points NR they are refracted and emerge from the lens convergingly towards a focus V in the tube C, but at O and S they are intercepted by the plate glass D, a portion of the rays are reflected by its polished surface in the direction E, and rays not reflected or absorbed are transmitted and pass to form a focus at V—the principal focal distance of the lens G, and again diverge in the direction WX. The rays reflected from the surface of the plate glass form a focus at U (which is also the focal centre of the eye E), at the same distance in front of the plate glass D as V is behind it; these rays again diverge and illuminate a portion of the fundus at TP.

2nd. *Reflection*:—Let E (fig. 2) represent the same eye illuminated as just described; D the plate glass; and HI the lenses in the camera tube. Rays from any portion of the illuminated fundus as *a*, are reflected from the fundus and emerge from the cornea at *bc*, the width of the dilated pupil, and proceed to the plate glass D, parallel, where some of its rays are reflected from the plate glass through the lens G in the direction of the source of illumi-

nation, but other rays proceed to *de*, where they are incident on the lens H by which they are refracted, and they would proceed to a focus at the principal focal distance of the lens H (viz., at P at five inches) but they are again intercepted at *fg* by the lens I, which refracts them to an earlier focus, at *h*. In the same way rays from *i*, on E's retina, proceed from the cornea parallel to the axis *ikm* and are also refracted by the lenses H and I, and are brought to a focus at *o*. In like manner all points intermediate between *i* and *a*, on E's retina, are reflected from the fundus, and refracted by the lenses forming an inverted image of *ia* at *oh*, which is received upon the ground glass placed at F.

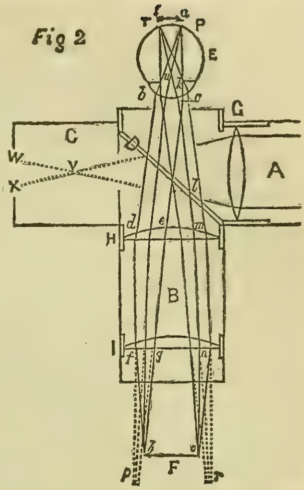


FIG. 4.

ADVANTAGES.

The advantages I claim for this instrument are :—

1st. The simplicity of its construction, taking into consideration its twofold purpose, namely, as an ophthalmoscope and as a photagraphing instrument. My friend Dr. Noyes, of the New York Eye Infirmary, constructed an instrument for photographing the fundus oculi, and which was, I believe, to a considerable extent successful, but its construction was too complicated and the instrument too expensive to be generally adopted. Dr. Noyes' instrument is constructed somewhat on the principle of the binocular microscope. Any good optician can construct this new instrument. The one I exhibit to the Institute was made by Charles Potter, No. 20, King-street East. They can be had complete for $10.

2nd. The limited experience necessary in order to use it successfully. The ordinary Ophthalmoscope requires months of practice before it can be used satisfactorily.

3rd. Being able to see the aërial image free from reflections from the object lens, which reflections are serious obstacles to beginners.

4th. Being able to receive the image either of a healthy or diseased fundus upon a screen of ground glass, which can be seen by a number of persons at the same time, and can be taken advantage of by gen-

tlemen lecturing upon the physiology of the eye, or upon the pathology of its deep structures.

5th. With it, artists will be enabled to make coloured diagrams of the internal eye, which, with the instruments now in use, has never yet been effected ; thus Mr. Hulke, in his Treatise on the Ophthalmoscope, and Jabez Hogg in the preface to his Manual of Ophthalmoscopic Surgery, June, 1863, apologising for the imperfections of the diagrams illustrating their works, state that it is impossible to procure the services of artists having the requisite knowledge of the use of the Ophthalmoscope.

6th. With this instrument I have demonstrated that photographs can be taken showing the details of the fundus of the eye.

In conclusion, I would express the hope that the invention of this instrument will contribute something towards popularizing Ophthalmoscopy, as, in investigating diseases of the eye, the Ophthalmoscope is undoubtedly even more essential than the Stethoscope in diagnosing diseases of the heart or lungs ; and I trust its use will aid in banishing from ophthalmic nomenclature the indefinite term of amaurosis, where, as Walther observed, "the patient and physician are both blind."

ON INSCRIBED SLING-BULLETS.*

BY THE REV. JOHN M^{c}CAUL, LL.D.,

PRESIDENT OF UNIVERSITY COLLEGE, TORONTO, AND OF THE CANADIAN INSTITUTE.

THE leaden bullets, which were thrown from slings, were called in Greek *μολύβδαιναι*, and in Latin *glandes;* the former indicating the material, "lead," the latter, the shape, "acorns." As an interesting and well-prepared account of the use of such mis-

* Mommsen, *Corpus Inscriptionum Latinarum,* i. Berlin, 1863.
Ritschl, *Prisc. Lat. Mon. Epig. ad archetyporum fidem exemplis lithographis repræsentata,* Berlin, 1862.
Boeckh, *Corpus Inscriptionum Græcarum,* ii. Berlin, 1833.
Franz, " " " iii. Berlin, 1853.
Curtius, " " " iv. Berlin, 1856.
De Minicis, 'Sulle antiche ghiande missili e sulle loro iscrizioni,' *Atti della Pontef. Accad. d'Archeol.* xi. Rome, 1844.
Hawkins, *Archæologia,* xxxii. London, 1847.

siles, in military operations, is given, in the *Archæologia*, vol. xxxii., by Mr. Walter Hawkins, it is unnecessary for me to discuss the subject in this aspect, especially as my object is to treat them not so much historically as epigraphically. A few preliminary remarks, however, may be useful before entering on the examination of the inscriptions. The bullets, which we are considering, were cast in a mould, and bore letters or devices, or both, on two sides or on only one. In form they were more like an almond than an acorn, but many are pointed at both ends; in size, they are generally about one inch and a half in extreme length, and under one inch in extreme breadth; and in weight they are stated* to vary from one and a half to three and half ounces. As slings were frequently employed in sieges,† by both parties, the greater number of the extant specimens have been discovered in or near towns which were besieged.

Those that bear Greek inscriptions have been found chiefly in Sicily, but also in Cephallenia and Corcyra, and at Athens, Marathon, and Corinth. The following are the principal varieties of inscription :—

(1) The name of a man :

‡ΚΑΛΛΙΣΤΡΑΤΟΥ, §ΕΥΒΟΥΛΙΔΑΣ.

(2) The name of a place, or of a people :

§ΚΑΤΑΝΑ, ||ΕΛΛΕΝΙ.

(3) The name of a deity :

||ΗΡΑΚΛΕΙ.

(4) The name of a man in connection with "victory."

**ΑΘΗΝΙΩΝΟΣ ΝΙΚΗ.

(5) The name of a deity in connection with "victory."

||ΔΙΟΣ ΝΙΚΗ, ||ΝΙΚΗ ‡‡ΜΗΤΕΡΩΝ.

(6) Words conveying orders, jokes, or sarcasms :

††ΔΕΞΑΙ, ‡‡ΕΥΣΚΗΝΟΥ, ‡‡ΤΡΩΓΑΛΙΟΝ.

There are also different devices, as a thunderbolt, a leaf, a scorpion.

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* *Archæologia*, xxxii. p. 104.

† Livy, xxxviii. 29; Sallust, *Jugurtha*, 57; Appian, *de bello Mithridat.* 32, 33 Tacitus, *Annals*, xiii. 39.

‡ Boeckh, *Corp. Inscrip. Græc.* n. 1866.

§ Franz, " " " nn. 5570, 5687.

|| Curtius, n. 8530*d*.

** Franz, nn. 5570, 5748.

†† Curtius, n. 8529.

‡‡ Curtius, nn. 8530*a*, 8530*b*.

The *glandes*, that bear Latin inscriptions, have been found* chiefly at *Enna*, *Asculum*, *Firmum*, and *Perusia*. They have nearly the same varieties as those which I have already noticed.

(1) †L·PISO·L·F COS, †Q·SAL IM.
(2) ‡FIR, OPITERGIN.
(3) §MAR
VLT.
(4) **C·CAESARVS
VICTORIA.
(6) ††FVGITIVI PERISTIS, ††FERI, ††ESVREIS ETME CELAS.

There is a peculiar class inscribed with the designation of legions, as

(7) ‡‡L·V·M P FEL, ‡‡L·XII SCAEVA PR·PIL, ‡‡L·MAENIVS PR·L·XII X·MILLIA.

(1) The names of men inscribed on these objects were those of the chiefs, or commanding officers, or persons who ordered the casting of the bullets. On one|| we have the maker's name clearly stated, *scil.* T. FABRICIVS FECIT.

L·PISO·L·F·COS, *i.e. Lucius Piso, Lucii filius, consul,* on a *glans* found at Enna, is *Lucius Calpurnius Piso,* who was consul in 133 B.C., and led an army in that year against the slaves under Eunus, in Sicily. Enna, near which this bullet was found, was not captured by him but by his successor, *Rupilius.* We may infer, however, from this and similar inscriptions, as Mommsen suggests, that he had attempted to take it. Q·SAL IM stand for *Quintus Salvidienus* [*Rufus Salvius*] *Imperator,* who had a command at Perusia, in 41 B.C. He was on his way to Spain with six legions, when he was

* Mr. Hawkins, *Archæol.* p. 105, observes: "Specimens of sling-bullets with Roman characters, are far more scarce than those with the Greek letters. The largest number have been found at Florence, where (as conjectured) there was formerly a Roman arsenal." I am not aware of the authority on which these statements have been made. A considerable number have been found in Tuscany, at *il Castellare,* not far from Pisa. See Targioni Tozzetti, *viaggi in Toscana,* i. p. 352.

† Mommsen, *Corp. Inscrip. Latin.* nn. 642, 689.

‡ nn. 652, 710.

§ n. 686.

** n. 685.

†† nn. 647, 649, 692.

‡‡ nn. 695, 700, 701.

|| Mommsen, n. 711.

recalled by Caius Cæsar, to take part in the siege. Eckhel, v. 299, notices a denarius having on one side the head of Cæsar, with the legend C·CÆSAR·III·VIR·R·P·C, *i.e. Caius Cæsar Triumvir Reipublicæ Constituendæ :* and on the other a winged thunderbolt, also found on this *glans*, with the legend Q·SALVIVS·IMP·COS·DESIG, *i.e. Quintus Salvius Imperator Consul Designatus.* The date is almost certainly determined to the year 41, for in the year following *Quintus Salvius* was killed, as we learn from Dio, xlviii. 33. On a *glans*, which is a memorial of Cæsar's hostilities with the sons of Pompey in Spain, we have a similar inscription: CN·MAG IMP, *i.e. Cneius Magnus Imperator, scil.* Cneius the son of Pompey the Great. From Mommsen's account of it, n. 681, it does not appear whether it was found at *Munda*, where the decisive battle was fought, or at *Attegua*, which was besieged during this war.

ΚΑΛΛΙΣΤΡΑΤΟΥ, on a bullet found in Corcyra, seems to be the name of the *Prytanis eponymus*, in whose year the missiles bearing the name were cast. See Boeckh, nn. 1865, 1866.

The last two inscriptions in (7) have the names of the centurions, who ordered the casting of the *glandes, scil. Scæva* and *Lucius Mænius*, of the 12th legion. Mommsen regards them both as *primipili*. Of the first there can be no doubt, as the letters PR·PIL prove his rank; but as the latter is designated merely by PR·, I am inclined to think that he was *Princeps*.

X·MILLIA, 10,000, of course, gives the number of bullets that were ordered.

In the *Journal of the Archæological Institute*, 1863, p. 198, we find another example of the *primipilus*, on a *glans*, (in the possession of Mr. Fortnum), which was also found at Perusia. It bears the inscription,—ATIDI·PR·PIL·LEG·VI, *i.e. Atidii Primipili legionis sextæ.*

(2) The names of towns may have indicated the places where the bullets were made, or from which those who used them came, or in defence of which they were thrown; and the names of peoples were of those by whom or for whom they were thrown. FIR· in n. (2) is inscribed on a *glans* found* on the bank of the river *Truentus.*

* Mr. Rich states that this bullet was "found at the ancient Labicum." This is a mistake, probably derived from Ficoroni, who makes the same statement. See Mommsen, n. 652.

Mr. Rich, in his "Companion to the Latin Dictionary," under *glans*, observes that 'the letters are for *firmiter*, "Throw steadily," or *Feri Roma* (Inscript. *ap.* Orelli, 4932), "Strike, O Rome!"' I much prefer Mommsen's suggestion, that FIR· are the first three letters of FIRMO, in the sense "thrown from Firmum," and that the allusion is to the siege of that town, whilst occupied by Cn. Pompeius Strabo, during the Social war, in 90 B.C.

The bullet bearing ΕΛΛΕΝΙ, *i.e.* Ἑλλήνων, or Ἑλληνίκων, is said to have been found on the plains of Marathon, but its genuineness is *justly doubted. †ITAL, *i.e. Italicorum*, is on *glandes* which were thrown on the side of the *Socii Italici*; and those which are inscribed OPITERGIN belonged to the *Opitergini*, who were warm allies of Cæsar.

(3) The names of deities are most probably of those gods and goddesses, whose aid was specially invoked by the combatants on either side, or to whom the missiles were consecrated, as MAR·VLT, *Marti Ultori*.

(4) The names of men in connection with "victory," of course indicate the wish that those who are named may succeed. The inscription ΑΘΗΝΙΩΝΟΣ ΝΙΚΗ, on μολύβδαιναι found in the *campus Leontinus*, shows that such bullets were thrown by the slaves in the Servile war in Sicily, 102–99 B.C., for Athenio was a leader in that insurrection. The *glandes* found near Perusia, which bear the words C·‡CAESARVS·VICTORIA, were thrown by the besiegers, partisans of Octavianus.

(5) The inscriptions, in which the names of deities are used in connection with "Victory," indicate the gods or goddesses who were believed to be specially interested in favour of each side, or who had been chosen as patrons. Thus ΔΙΟΣ ΝΙΚΗ may have been on the Roman missiles, and ΝΙΚΗ ΜΗΤΕΡΩΝ (otherwise ΝΙΚΗ ΜΑΤΕΡΩΝ) on the Sicilian. That the *Deæ Matres* were worshipped in the island, appears from the statements of Diodorus Siculus, iv. 79, 80, and Posidonius, in Plutarch, *Marcellus*, c. 19, independently of the evidence supplied by this inscription. Another of these Sicilian bullets is inscribed with the words ΝΙΚΗ ΜΑΤΕΡΟΣ, from which

* Some, however, have been found there, which seem to be unimpeachable. See Dodwell's *Tour*, ii. 161. Those found at Athens were probably thrown during the siege by Sylla.

† Ritschl, Pl. viii. nn. 20, 21.

‡ In *Cæsarus* we have the archaic termination of the genitive of the third declension. Thus *Cererus*, in n. 566, *hominus*, in n. 200, *patrus*, in n. 1469, &c.

we may derive confirmation of the statement of Cicero, *Verr*, iv. 44, that there was a temple of the *Magna Mater* amongst the *Enguini*.

The inscriptions, classed under (6), are generally addresses to the missile or to the enemy FERI, "strike," is as a direction to the *glans* not to miss. Mommsen aptly cites, in illustration, a passage from the *Marcellus* of Plutarch, c. 8,—ἐν ταῖς μάχαις, ὅταν διώκωσι τοὺς πολεμίους, πυκνὸν τὸ φέρι, τουτέστι παῖε, παρεγγυῶσιν ἀλλήλοις. Orelli, n. 4932, on the authority of Cardinali, gives another form in which *feri* is used:—ROMA FERI, which he explains—"O dea Roma, feri hostem!" The reading of this inscription is doubtful: the first letter seems to be P not R, and the final A resembles an imperfect P. As the two words are on different sides of the *glans*, it might appear uncertain with which we should begin. There can be little doubt, however, that *feri* is the commencement, as in another similar inscription, FERI PIC, *i.e. feri Picentes.* This consideration should lead us to prefer, with Mommsen, either *Pomp*[eium], *scil.* the general in command of the Romans in *Picenum*, or *Roma*[nos]. ΔΕΞΑΙ, "take this," was imitated by the Latin *accipe.* This latter word appears on a bullet, exhibited by the Count d'Albanie, at a meeting of the Archæological Institute, in 1863. It is in reversed letters, and has but one C. The cause of the inversion in this and in other similar examples, is that the letters as cut in the mould were not inverted, as they should have been, in order that the impression might be read in the usual direction.

It is worthy of remark, that the bullet, exhibited by the Count, was "stated to have been found amongst the scoria of an extensive ancient lead-working in the kingdom of Granada. It is believed that the mine was worked by the Romans and also by the Celtiberians, and the scoria are still smelted in order to extract portions of silver."

The letters ΦΑΙΝΕ appear on the bullet presented by Mr. Hawkins to the Society of Antiquaries of London, and described by him in the article in the *Archæologia*, that I have mentioned in p. 93. In that paper he gives the following account of the inscription:

It appears to exhibit on one side the characters ΦΑΙΝΩ or ΦΑΙΝΕ, commencing at the smaller or taper end, and extending to the larger, where they are slightly defaced in consequence of the forcible compression of the pellet from impact. If the word be ΦΑΙΝΟΥ, or in the Ionic dialect ΦΑΙΝΕΩ, it will mean "Appear," or "Show yourself."

From these remarks it appears, if I understand them correctly, that Mr. Hawkins is dissatisfied with the use of ΦAINE in the sense, "appear," or "show yourself;" and thinks that if this had been the meaning, we should have had the passive or middle ΦAINOY; and yet in another place, p. 105, he translates ΦAINE "appear." Again, he seems to doubt whether the word was ΦAINΩ, or ΦAINEΩ, which latter he believed to be the Ionic form of ΦAINOY. On reference to the representation of the bullet in his drawing, it is plain that the word is neither ΦAINΩ nor ΦAINOY, but ΦAINE; after which there may, perhaps, have been another letter. What that other letter was is of course doubtful, but it certainly was not Ω. ΦAINEO, not ΦAINEΩ, is another form of ΦAINOY. Mr. Hawkins had, I think, some reason to be dissatisfied with the use of ΦAINE in the sense "appear," "show yourself;" but the passive or middle ΦAINOY, is not necessary, as *φαίνω* is sometimes used intransitively. My objection to either of these words in the assigned signification is, that I do not recollect having met with a similar instance, whilst I at once call to mind the the use of *φάνηθι* by the Tragedians; *e. gr.* Æschylus, *Persæ*, 667; Sophocles, *Ajax*, 697; Euripides, *Phœnissæ*, 1748.

The true explanation of the inscription is, in my judgment, suggested by the consideration of the probable date. Mr. Hawkins judiciously remarks on this subject:

> This specimen was found lodged in the Cyclopian walls of Samé in Cephalonia. The determination of its date must depend on the degree of probability which may be attached to the supposition that it was deposited there by one of the Achæan slingers from Ægium, Patræ, and Dyme, of whom there were one hundred in the army with which the Roman consul, M. Fulvius, reduced that place, after a siege of four months, B.C. 189.—(Livy, xxxviii. 20.)

The siege of Same took place, as is well known, at the end of the Ætolian war, in which Phæneas, ΦAINEAΣ, took a prominent part, as Prætor of the Ætolians. (See Livy, xxxii. 32; xxxiii. 3; xxxvi. 28; Polybius, xvii. 1; xviii. 20; xx. 9.) In this year, B.C. 189, he, in conjunction with Damoteles, had obtained peace from M. Fulvius, from which, however, the Romans specially excluded Cephallenia. (See Livy, xxxviii. 8; Polybius, xxii. 12.) It appears, then, that if there was a letter after ΦAINE, it probably was A, *i.e.* *Φαινέα* for *Φαινέου*. The inscription of his name seems to indicate that the bullet was Ætolian, cast whilst he was Prætor (see p. 95), or it may have been

so stamped to signify to the besieged that Phæneas was then on the Roman side.

ΕΥΣΚΑΝΟΥ is on a *glans* made of brass. Vischer explains it as standing for εὖ σκήνου, an ironical address to the person struck by it, "be lodged well," "take good quarters." The view of Curtius, that it was an address to the missile to place itself well in the head of the enemy, seems to me preferable. ΤΡΩΓΑΛΙΟΝ, *i.e.* τρωγάλιον, is on a bullet preserved at Argos. It means "a sweet-meat," or "fruit for dessert," and is used here in the sense—'Here's a sugar-plum for you.' On the original the inscription stands thus:

ΤΡΩΓ
Ε
ΑΛΙΟΝ,

whence Goettling proposed the strange reading Τρῶγε ἅλιον, in the sense, I presume, "Bite it in vain," like our "This is a hard nut to crack." Curtius explains the E as a numeral denoting the number of bullets thus inscribed. To me this explanation seems unsatisfactory, and I am inclined to suggest that it was intended that τρωγ should be taken twice, *scil.* τρῶγε τρωγάλιον, "eat a sugar-plum."

ESVREIS ET ME CELAS, *i.e. esuris et me celas*, "you are starving, and hide* it from me," refers to the famine in Perusia, during the siege, and the extraordinary care with which L. Antonius endeavoured to conceal it from the besiegers. See Appian, v. 35. On the same *glans*, which bears C·CAESARVS VICTORIA, we have also

LANTONI CALVI†
PERISTI,

i.e. L. Antoni calve peristi, "Lucius Antonius, you bald-pate, you are undone." There is no historical testimony as to the baldness of Lucius Antonius, but De Minicis believes that he has found evidence of it on a denarius bearing a representation of his head.

Some expressions in inscriptions of this class are, as might be expected, very coarse. Thus we have on one, belonging to the be-

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* This use of *celare* with the accusative is not uncommon. Thus in Cicero, *Phil.* ii. *Etenim vereor, ne aut celatum me ab ipsis illis non honestum*, &c. The meaning of *celatum me* is not "that I was concealed," but "that I was kept in the dark," "that it was concealed from me." See *Epist. ad fam.* vii. 20.

† The second I is effaced, II standing as usual for E; or the horizontal lines of E have disappeared.

sieged, *PET CVLVM OCTAVIA, *i.e. pete culum Octaviani;* and another, thrown by the besiegers, bears †LA CALVE FVLVIA CVLVM PAN, *i.e. Luci Antoni calve, Fulvia, culum pandite.*

(7) The legionary inscriptions appear on *glandes* found in Picenum and also in Perusia, such as LEG·XX, L·XV, *Legio vicesima, Legio quinta decima,* L·V·M P FEL, *Legio quinta Macedonica pia felix* It is especially worthy of observation, that amongst this class are noticed some bearing epithets, which were certainly not used before the time of the Emperors—*e. gr.*,

L·XII
FVL

Legio duodecima‡ *fulminata,* and

LEG·XXX
VV

Legio tricesima Ulpia victrix. Suspicions are at once excited as to the genuineness of *glandes* of this class, especially those regarding which Mommsen observes, "*non reperiri apud scriptores antiquiores, eas que nuper demum emersisse omnes et maxime insinuasse se in museum Minicianum.*" And yet there are some, regarding which there can be no reasonable doubt.

From the foregoing pages it appears that many of the inscriptions on the Greek and Latin sling-bullets may be read and explained without much difficulty. There are a few, however, particularly those consisting of merely initial letters, of which no probable interpretation can be offered. Of those, which are doubtful, the most remarkable is one that has frequently been found at Perusia. It is given by Mommsen, n. 687, as LVFVIASIA, or, rather, LVFVLASIA; but on comparing Ritschl's, Pl. ix. nn. 40, 41, 42, 43, 40*b*, and 42*b*, it seems certain that the true letters are LVFINASIA, as they are clearly written in n. 41. From a reading of the portion after LV as INEMASA, De Minicis ingeniously suggested *sine maza*, with reference to the want of provisions in Perusia. This is, however, undoubtedly incorrect. Mommsen can offer no other explanation than that LV stands for *Lucius, scil. Lucius Antonius,* and

* Mommsen, nn. 682, 684. It is extremely difficult to decipher this inscription. The reading given above is believed to have been suggested by the accomplished epigraphist, Borghesi.

† See Kellermann, *Vigil. Rom.* n. 249.

FVL for *Fulvia*, whilst ASIA indicates *Marcus Antonius*, who was at the time in Asia. The use of LV for Lucius, although a solœcism, may, he thinks, be excused "*tali plebei hominis scriptione.*" There are, I think, but few who will accept this view. And yet in this case, as in many others, it is far easier to tell what interpretation should be rejected than it is to propose one which should be adopted.

Of the various expansions, that have presented themselves to my mind, there is not one which I regard as sufficiently probable to induce me to propose it.

In addition to leaden *glandes*, there have also been found in Sicily* objects of a similar form, made of clay, *argilla*. I have never seen one, but they are described as being of the size of an egg of our domestic fowl, and having on one side a figure, indistinct, but said to resemble Hercules, a man with a sword, a man with a helmet in one hand and a shield in the other, or a man binding shoes on his feet. The inscriptions on them generally consist of the following abbreviations: ΠΡΩ ΦΥΛ, *i.e.* πρώτα φυλά; ΔΕΥ ΦΥΛ, *i.e.* δευτέρα φυλά; ΤΡΙ ΦΥΛ, *i.e.* τρίτα φυλά, followed first by ΦΑ, which seems to stand for φρατρία, then by ΠΛΕ, ΛΑΚΥΝ, and other letters, probably the commencement of the names of places, and finally by names of men, supposed to be of magistrates, as ΦΙΛΟΞΕΝΟΣ ΑΡΚΕΣΙΛΑ, *i. e.* Φιλόξενος Ἀρκεσίλα. Franz, n. 5468, remarks: "*Cui usui inservierint non constat. Ratione habita figurarum impressarum haud scio an pertineant ad milites.*" I am inclined to think that these objects are similar to those described by Cæsar, *Bell. Gall.* v. 43: *ferventes fusili* ex argilla glandes fundis *et fervefacta jacula in casas, quæ more Gallico stramentis erant tectæ, jacere cœperunt.* This use of φυλή and φρατρία calls to mind the Homeric: Ὡς φρήτρη φρήτρηφιν ἀρήγῃ, φῦλα δὲ φύλοις; and the words appear to denote divisions and sub-divisions of an army. See Thucydides, vi. 98. Hence we may conjecture that these missiles were made for the bodies named thereon, and that the names of places and of men are used in the senses already noticed in pages 95, 96.

Inscribed sling-bullets were also used for the purpose of communicating information to the besieged or the besiegers; and, in addition to them, were similar, but apparently different objects, thrown from slings, called by Appian, *Mithridat*, 31, πεσσοὶ ἐκ μολύβδου.

* See Franz, *Corp. Græc. Inscrip.* iii. nn. 5468, 5567, 5620, 5686, 5743; also the authorities cited by him:—Alessi, "'Littera sulle ghiande di piombo iscritte, trovate nell' antica città di Enna,' Palermo, 1815;" and Mommsen, Zeitschrift. f. Altreth. 1846, n. 98, p. 784.

Mr. Hawkins, *l. c.*, notices "many leaden bullets for slings, found among the ruins of Eryx," [in Sicily], "some of which are inscribed with imprecations. (See Captain Smyth's 'Sicily and its Islands,' p. 242.)" He gives as an instance "one of these inscriptions, which is translated: Your heart for Cerberus."

No sling-bullets have, so far as I am aware, been discovered in Great Britain There are, however, peculiar leaden objects, bearing devices and inscriptions, which have been found at Felix-Stowe, in Suffolk, and at Brough-upon-Stanmore, in Westmoreland. It is not clear to what age they belong, or for what purpose they were intended. See Mr. C. R. Smith's *Collectanea Antiqua*, iii. p. 197, and *Journal of Archæological Institute*, 1863, p. 181. Mr. Smith appears to regard them as "Roman seals fastened to merchandize of some kind," but observes that "their general character seems to bespeak a Phœnician origin."

I do not see sufficient grounds for either of these opinions.

P.S.—Since the foregoing article was in type, I have noticed a report, in the *Gentleman's Magazine* for June, 1863, of the proceedings at a meeting of the Society of Antiquaries of London, on May 7th.

From this report it appears that the inscription on the *glans* exhibited by the Count d'Albanie was deciphered by Mr. Franks, who was "of opinion that the βουστροφηδόν character of the inscription was due to Phœnician influence,—the bullet having been found in a lead-mine in Granada." In this opinion of the learned Director I cannot concur: the inversion of the letters in this instance, as in Mommsen's n. 646, seems to me to be merely the result of a blunder of an unskilled or careless workman, who had not inverted the letters on the mould so as to give an impression that could be read in the usual direction. There are examples, however, of another kind of inversion, whereby the letters are turned upside down, which seems to have been intentional and not due to accident or mistake. See Mommsen's nn. 682, 694.

NOTE ON THE OCCURRENCE OF ALLANITE IN CANADIAN ROCKS.

BY E. J. CHAPMAN, Ph. D.
PROFESSOR OF MINERALOGY AND GEOLOGY IN UNIVERSITY COLLEGE, TORONTO.

(*Laid before the Canadian Institute, February* 20, 1864.)

The mineral *Allanite* or *Orthite* is a comparatively rare species. Up to the present time, the only announcement of its occurrence in Canada, is contained in the following brief notice by Prof. Sterry Hunt, given in the last Report of the Survey (1863.)

" CERIUM :—Some small crystals of a mineral having the aspect of Allanite were found in a feldspathic rock near Bay St. Paul, and gave by analysis a portion of oxide of cerium with lanthanum. Minute crystals of a similar mineral have been observed in a rock composed of labradorite and hypersthene, from Lake St. John."

In a collection of specimens, obtained from the Muskoka district of Upper Canada by Mr. H. White, P. L. S., and lately submitted to me for examination, I found a number of sharp-edged fragments of a black amorphous mineral, which proved to be a compact variety of allanite. These fragments had much the appearance of anthracite coal, or pitchstone. Some of them were as large as hazel nuts, and the whole weighed over two ounces. They were obtained, according to Mr. White and his son, from a vein an inch or more in width, at Hollow Lake, the head-waters of the South Muskoka. This lies far within the Laurentian area; but I am unable to ascertain whether the vein occurs in an ordinary gneiss rock, or in one of the anorthosites of the upper part of the Laurentian series.

The presence of this mineral, in such comparative abundance, in our Laurentian rocks, is a fact of some interest; and I have therefore thought it desirable to insert a short notice of the discovery in the *Canadian Journal.*

The allanite of this locality constitutes a somewhat distinct variety, characterized more especially by its want of crystallization. It appears to resemble the variety from East Bradford, Chester County, Pennsylvania, analysed by Rammelsberg, (*Mineral chemie*, 744, 746), and that from Monroe, Orange County, New York, examined by Genth (*Am.*

Journ. Science [2] xix., 20.) The specific gravity, however, is considerably lower than in these latter varieties, and in others from Pennsylvania analysed by Genth. One specimen gave me 3.255; another, apparently quite free from foreign matter, and carefully weighed, 3.288. Rammelsberg's specimen from East Bradford, Pa., gave 3.535; and that from Orange County, New York, as examined by Genth, yielded 3.782. Prof. Brush (Dana's Mineralogy, first supplement) obtained from the latter a still higher value, 3.935. The Pennsylvania specimens analysed by Genth varied in sp. gr. from 3.491 to 3.831. The lowest recorded density of allanite is 3.193, found by A. Erdmann in a blackish-green variety from Tunaberg, Sweden. These variations, although, perhaps, partly due to structural differences, arise most probably from the variable amount of water present in the different specimens.

The leading characters of the Muskoka allanite are as follows:—

Amorphous: with compact structure; shining, pitch-like lustre; and more or less conchoidal fracture. Colour, jet-black; streak, light-grey. H = 5.75; sp. gr. = 3.288.

Heated in the bulb-tube, it decrepitates, and gives off a small quantity of water.

Before the blow-pipe, it intumesces exceedingly, and fuses with great readiness into a black, opaque, and very feebly magnetic globule.

With Borax, it is rapidly attacked, and is dissolved in considerable quantity. The glass shews the reactions of cerium and iron oxides. If a little phosphor-salt be added to it, the glass may be rendered milky by flaming. This reaction, not hitherto noticed in books, holds good with other silicates of cerium.

With phosphor-salt, a "silica skeleton" is obtained, and the glass becomes opaline on cooling.

With carb. soda, the test-substance forms a yellowish slaggy mass, which, on the addition of a little nitre, exhibits the reaction of manganese.

In boiling chlorhydric acid, decomposition is readily effected—the silica separating in a gelatinous state.

The filtered liquid yields a precipitate with ammonia, from which, a certain amount of alumina is dissolved out by caustic potash. In the original solution, filtered from the ammonia precipitate, oxalic acid shews the presence of lime.

The substance, consequently, is an undoubted allanite: consisting essentially of—SiO^2, Al^2O^3, Fe^2O^3, CeO, CaO, MnO, (a trace,) and a small amount of water. An exact analysis would probably reveal, in addition, the presence of LaO and YO, with perhaps a half-per-cent. of MgO, NaO, and KO. Part of the iron may also be in the state of FeO.

University College, Toronto,
February 1, 1864.

DESCRIPTIVE CATALOGUE OF COINS, ANCIENT AND MODERN, IN THE COLLECTION OF THE CANADIAN INSTITUTE.

BY THE REV. DR. SCADDING,
LIBRARIAN TO THE INSTITUTE.

NO. 1.*

GREEK COINS.

I. SILVER.

(A) OF AUTONOMOUS CITIES.

1. Chalcis in Eubœa.† Obverse—Female Head to the right, with ear-drop. (Aphrodite.) Reverse—an Eagle and Serpent. Legend XA. Drachma. Weight—2 dwt. 3 grs., Troy.‡

* In 1857, Major Rains, at the instance of the late A. H. Armour, Esq., presented to the Canadian Institute a collection of silver and copper coins, consisting principally of denarii, quinarii and assaria of the Roman Emperors, but com-

† Coins of Chalcis, the capital of the district of Chalcidice in Syria are found, but they are generally of the times subsequent to the Roman conquest, and bear the names (in Greek characters) of Roman Emperors. Chalcis in Eubœa took its name from the *χάλκεα μέταλλα* (copper mines) in its neighborhood.

‡ The weights of the coins are given and their denominations as thence derived, but the latter only conjecturally, the remark of Eckhel in his Chapter *de pondere ac valore monetae veteris*, being borne in mind. "Fatendum est multa esse adhuc in hac causa dubia atque incerta, multa Cimmeriis adhuc noctibus involuta, quod satis ex eruditorum litibus atque dissidiis apparet.' Vide plura, *Doctr. Num. Vet.* Vol. I. xxxiv.

2. Elea or Velia (Gr. Hyele) in Lucania. Obverse—Fine head of Pallas to r.; on the helmet a gryphon; behind the neck A.* Reverse—a lion stalking to r. In the field a dolphin and Φ. In the exergue ......ΛΗΤΩΝ. [ΥΕΛΗΤΩΝ.†] Drachma. Weight—4 dwt. 17 grs.

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prising also a few coins of the republican era, and some Greek drachmæ, chalci, dichalca, &c., with specimens of the coinage of various States of Europe of rather ancient dates.

In the preceding year (1856) H. B. Hope, Esq., presented to the Institute a number of early English coins.

The gifts of these two gentlemen, together with a few others, amounting in all to some 340 pieces, constitute the present collection, of which a complete classified and descriptive Catalogue has lately been made.

It is intended to insert in the *Journal* those portions of this List that may be supposed to possess some interest for the Canadian numismatist; and it is hoped that members and others who may have in their possession historic coins, ancient or modern, European or of this Continent, will be induced to add some of them to the (at present) very modest Cabinet of the Institute.

It will be seen that this collection, although containing pieces of considerable value to the student, is entirely destitute of specimens of the large-sized coins and medals which in the Cabinets of Europe illustrate so exquisitely the history and the arts of by-gone centuries—of times, which, in some instances, have left no other records.

* The A may indicate the name of the designer or engraver of the die The lion on the reverse refers to an *ex voto* figure of that animal offered in the temple at Delphi, on the first emigration of the people of Phocis to Asia. The Φ is probably the initial of Philogenes, one of the leaders of the expedition. The dolphin indicates that Velia was a maritime community. The dolphin and trident on the Great Exhibition Medal of 1851 imply the same thing in regard to England.

† This coin is described in Rasche, *Lex. Rei Num.*, vol. x. p. 801; and there the epigraph is given in full. The name of the inhabitants of the πόλις or state occurs on Greek coins usually in the possessive case. The ellipsis is νόμισμα. Ὑελήτων implies that it is a coin of the Hyeletae. The original colonists, Phocaeans from Alalia, in Corsica, named the place (B. C. 543) Hyele, altered by the later Italians to Elea, Helia and Velia. ("Oppidum Helia, quae nunc Velia." Plin. iij. 10.) Cicero dates a letter to Trebatius "xiij. kal. Sext., Velia." It was situated on the sea coast a little to the south of Naples, near the mouth of the Hales, which Cicero in the above mentioned letter calls a noble stream—"Halethem, nobilem amnem." As Elea, it gave name to the Eleatic School of Philosophy. Cicero (de Nat. Deor iij. 33) asserts that Zeno the Eleatic was here cruelly put to death,—"Zenonem Eleae in tormentis necatum." Horace refers to it as a place resorted to by invalids. He asks his friend Vala (Ep. j. 15) to inform him "Quae sit hiems Veliae," &c.

3. Histiaea in Eubœa. Obverse—Female head to r., with ear-drop. Reverse—Fortune seated on a prow holding a sail: on the prow a fulmen or thunderbolt.* In the exergue ΙΣΤΙ. Some letters vertically at the back of the figure, probably intended for ΑΙΩΝ, in continuation of ΙΣΤΙ. Half-drachma. Weight—1 dwt. 11 grs.

4. Leucas in Acarnania, a colony of Corinth. Obverse—Pegasus with rounded wings. Reverse—the same repeated. Underneath—Λ. The Λ may denote Locri Epizephyrii.† Quarter-drachma or obol. Weight—13 grs.

5. Neapolis in Campania. Obverse—Fine head of Artemis‡ to l., with ear-drop, and filleted: behind the neck an ivy-leaf and berries. Reverse—Victory crowning a human-faced bull.§ Behind—ΙΣ.|| In exergue ...ΠΟΛΙΤ., *i.e.* ΝΕΟΠΟΛΙΤΩΝ.¶ Didrachma. Weight—4 dwt. 9 grs

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* Fortune on the prow holding a sail, alludes to the etymology of Histiæa, viz.: ἵστον, a sail. This city, according to the list given in Il. ii. sent ships to Troy. The epithet πολυστάφυλος, *rich in grapes*, is there applied to it. The place was at a later period called *Oreus*, and *Oropus*.

† "Locri Epizephyrii in Bruttiis agnati sunt Corcyraeis, et per hos Corinthiis, quorum extant et aerei numi cum typo Palladis et pegasi." Rasche, *Lex. Rei Num.* Vol. iv., p. 1814

‡ The epigraph ΑΡΤΕΜΙΣ occurs on coins of Naples described in Rasche, v. 1130.

§ This figure symbolizes either the sun, which the people of Naples are said to have worshipped under the image of a bull with a human face and called Hebon, or the Vulturnus, the principal river of Campania. The Tiber is styled (Æn. viii 77.) *Corniger* Hesperidum fluvius regnator aquarum.

|| These letters, denoting an artist's name, are seen on many Neapolitan coins in Rasche, vol. v., 1138.

¶ A city, poetically called Parthenope, was "founded originally by the Cumœi; but afterwards being peopled by Chalcidians, and certain Pithecussaeans and Athenians, it was on this account denominated Neapolis." Strabo, v. 4, 7; *i.e.* Parthenope became Palaeopolis *the old city;* and the new settlement situated a little to the west of the old one, acquired the name of Neapolis. *new city.* The epigraph is nearly always ΝΕΟ-, not ΝΕΑ-ΠΟΛΙΤΩΝ on the coins, shewing that *Neapolis* was long regarded as a common, not a proper name; as doubtless "New College," Oxford, (properly St. Mary's) was. Νεοπολίτης is new burgher,—not a citizen of Newburg. This would be Νεαπολίτης, as is read on a few coins in Rasche. [On two or three the epigraph is Νευπολ., suggestive of Neu-borac-um as not an improper substitute for the rather awkward Neo-Eborac-um, usually given as the latinized form of "New York."]

6. Syracuse. Obverse—Head of Arethusa* to r. ; a beaded fillet confines the hair. Reverse—A sepia or cuttle-fish. Epigraph ΣΥΡ. [*i.e.* ΣΥΡΑΚΟΣΙΩΝ.] Quarter-drachma or obol. Weight—12 grs.

7. Syracuse. Obverse—An Eagle : in the field, three small globules. [=3 obols ?] Reverse—A Chimaera.† Half-drachma. Weight—1 dwt. 17 grs.

8. Thebes in Bœotia. Obverse—The Bœotian Shield. Reverse—The Cantharus of Heracles, surmounted by his club. Legend—ΘΕΒΗ.‡ Half-drachma. Weight—1 dwt. 15 grs.

(B) MONARCHICAL.

1. Philip II. of Macedon. Obverse—Head of Hercules, youthful and wearing a lion's scalp § Reverse—Jove seated, with eagle. Epigraph—ΦΙΛΙΠΠΟΥ, and monogram|| denoting place of mint or artist's name. Drachma. Weight—2 dwt. 15 grs.

2. Philip II. of Macedon, or Philip III. (Arrhidaeus), the successor of Alexander. Obverse—Youthful Head to r., with royal bandlet.¶ Reverse—Horseman with causia.** Epigraph—ΦΙΛΙΠΠΟΥ. Monogram. Half-drachma. Weight—1 dwt. 13 grs.

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* Syracuse, founded in the 8th century, B.C., consisted of five towns or wards, Acradina, Tycha, Epipolae, Neapolis, and Ortygia: in the latter, which was an island attached to the shore by a bridge, rose the famous fountain of Arethusa, the ἄμπνευμα σεμνὸν Ἀλφεῶ of Pindar, Nem. i. i.

† Here represented triform in respect of heads, according to the Hesiodic tradition, not the Homeric, which Lucretius (v. 902) ridicules:—

Quî fieri potuit, triplici cum corpore ut una
Prima Leo, postrema Draco, media ipsa Chimaera
Ore foras acrem efflaret de corpore flammam ?

The Chimaera was in reality a symbol of a volcanic district, like the Syracusan neighborhood.

‡ The E is archaic for H. This name is usually plural ; in Il. xiv. 323, we have Ἀλκμήνης ἐνὶ Θήβῃ, an expression that refers to the myth alluded to in the Cantharus and club before us. [The sign H for long E, arose from ƎƎ.]

§ Plutarch says of Alexander, the son of Philip, ὅτι τῷ γένει πρὸς πατρὸς μὲν ἦν Ἡρακλείδης ἀπὸ Καράνου. *Vit. Alex.* I.

|| The ingenious and interesting combinations of many letters in one character, called monograms, cannot be presented to the eye without the aid of the engraver.

¶ The simple fillet which, on some of the English coins, is seen on the head of the Queen is the royal *diadema*. Its passing more than once round the head may denote a plurality of crowns.

** The broad-brimmed Macedonian hat to keep off the καῦσις—the burning heat of the sun.

ON THE ABNORMAL VARIATIONS OF SOME OF THE METEOROLOGICAL ELEMENTS AT TORONTO AND THEIR RELATIONS TO THE DIRECTION OF THE WIND.

BY G. T. KINGSTON, M.A.
DIRECTOR OF THE PROVINCIAL MAGNETIC OBSERVATORY, TORONTO.

The climate of a locality with respect to any one of its meteorological elements is characterized principally by the mean annual value of that element, and its annual and diurnal periodic variations, including implicitly a statement of its normal values for each hour of every day throughout the year.

Now the observed value of an element, it is well known, is not generally identical with the normal proper to the epoch of observation, but continues above or below it for hours, and often for days, making digressions that are variable both in amplitude and duration.

One object of the present article is to ascertain the average *extent* of the abnormal variations, (as they are here called for want of another term,) or the digressions of the observed values of certain meteorological elements above or below the normals proper to the epochs of observation, and to exhibit such relations as may be found to subsist between these abnormal variations and the season of the year, the hour of the day, and the direction of the wind.

Another object of enquiry relates to the rapidity with which any element passes from one abnormal condition to another, and the dependence of this rate of change on the season, the hour, and the direction of the wind. To carry out this enquiry completely would involve the computation of the differences between the abnormal variations at consecutive hours throughout the series, and their arrangement in tables according to the season, the hour, and the wind that prevailed during the intervals between each hour.

The less laborious process to which recourse has been had, and which, though less accurate than the one above indicated, is sufficient for the approximate results at present sought, consists in employing for discussion the differences at *like hours* on consecutive days, between the abnormal variations, in the case of the temperature, and between the observed values, in that of the other elements. The differences between the observed values of an element at like hours of consecutive

days give the daily rate of change independently of the effect of regular periodic diurnal variation, though affected it may be by the hour chosen, should the element be systematically more liable to disturbance at one hour than another

As the normal temperatures for the same hour change perceptibly from day to day, in order to eliminate the effect of annual variation, the differences between the abnormal variations of temperature at like hours of consecutive days have been employed instead of the differences between the observed values, which, for the other elements, have been considered sufficient.

In seeking to establish the connection between the *change* in the condition of an element and the wind that accompanies it, the change has been referred to the *resultant* direction during the interval. When the direction has not varied greatly during the day, this method may be regarded as sufficiently accurate for the purpose designed; but if there be any very great change of direction, the resultant, though geometrically equivalent to the actual winds as they reach the anemometer, will not be necessarily equivalent in physical properties; and if the resultant wind be from a direction for which the whole number of resultants are few, errors will be introduced sufficient to conceal the true character of that particular wind in its relation to the element under consideration; and hence conclusions relative to the comparatively rare resultants, cannot be accepted for single months, unless the errors be rendered inappreciable by extending the series.

The tables in this article are derived from two series of observations —one from 1854 to 1859 inclusive, (two of the tables embrace also the year 1853,) and the other from 1860 to 1862. Those that relate to the pressure of dry air, the pressure of vapour, and the relative humidity are limited to the latter series; but the tables for the temperature and the barometer have been computed separately for both series.

The mean monthly and annual changes between the temperatures and the barometric pressures at like hours on consecutive days were computed in the first instance for the interval between 2 P.M. and 2 P.M. in the earlier series. Subsequently, when it was desired to connect the diurnal change with the daily resultant direction of the wind, since the resultants had been all calculated for the twenty-four hours, commencing at 6 A.M., it became requisite to take the differences also for that same interval. The arrangement found most convenient for collecting these differences, while it readily afforded the

monthly and annual mean changes on the average of the six years, would not, without greater labour than the occasion warranted, give the annual mean changes from 6 A.M. to 6 A.M. for the separate years. On this account, for the years 1854 to 1859, the annual means of the diurnal change in the temperature and barometer have been given for the interval commencing at 2 P.M.*

The normals to which reference is made in the temperature-tables, are deduced from the table of twenty-four-hour daily means given by General Sabine in his paper† on the *Periodic and Non-periodic Variations of Temperature at Toronto,* by applying the diurnal variations given (though with a contrary sign,) in the same paper.

The approximate normals of reference for the other elements are simply the monthly means at each of the six observation hours, derived from an average of several years.

The normals thus computed are tabulated and kept as standards to which the observed values of the elements are referred; the abnormal variations with their proper signs being entered in the daily register side by side with the observed values.

TABLES I. TO VII., ON TEMPERATURE

From table I we see that the average extent of an abnormal digression of temperature, without regard to sign, and irrespective of the hour and season, was 6°.5 on the average of nine years, and that the digression in different years never differed more than 0°.6 from this average.

In table II., which gives the abnormal variations without regard to sign for the different months, double weight is given to the earlier series in computing the means from 1854 to 1862. Double weight is also given to the earlier series wherever in subsequent tables the results of the earlier series are combined with those of the years 1860 to 1862.

The progression from month to month, though it shews that the digressions are decidedly larger in the winter than in the summer months, is not perfectly continuous. If the monthly means be collected in quarterly groups we have 6°.1 as the average digression in spring, 4°.9 in summer, 5°.8 in autumn, and 9°.1 in winter.

In table III. we have for each series separately, as well as for the two combined, the yearly and half-yearly mean abnormal variations at

* Throughout both series observations have been made on Sundays at 6 A.M. and at 2 P.M., so that no break on account of Sundays or holidays has occurred.

† Philosophical Transactions for 1853, pp. 154 to 159, and pp. 145, 146.

the six observation hours. If the annual means alone be regarded, there is nothing to warrant the belief that one hour is to any great extent more subject than another to thermic disturbance; but on referring to the hourly table for the separate *months,* from which table III. is derived, and comparing the numbers in the columns for 10^h, 12^h, 18^h, and 20^h with those for 2^h and 4^h, it was found that in the six winter months,(October to March,) the former group were, in nearly every case, number for number, greater than the latter group, and that exactly the reverse occurred in the other six months. Table III. shews that the winter half-yearly means are in every case greater, and the summer half-yearly means less, at each of the hours 10^h, 12^h, 18^h, and 20^h than at 2^h and 4^h. Hence it appears, from both series, that there is in winter a greater uncertainty respecting the temperature during the night and morning than during the hours of the day; whereas in summer the warmer hours are more subject to irregularity; or it may be briefly stated that the warm hours are most subject to disturbances of temperature in the warm months, and the cold hours in the cold months; the difference in the extent of the disturbance for each season being about 0°.8.

Table IV. gives the mean abnormal variations with their proper signs, arranged according to the direction of the wind at the instant of observation. In the results for the years 1853 to 1859 the variations are arranged in seventeen groups corresponding to the sixteen principal directions of the wind, and to light winds with a velocity not exceeding half a mile per hour, which it was the custom formerly to regard as calms. In the later series the variations are arranged in nine groups only, corresponding to the eight principal directions and to absolute calms.

From the observations of the first seven years, if each point be considered as including an angular space of 11°.15 on each side of it, it appears that the temperature is above or below the normal according as the wind blows from a point lying to the South or to the North of a line drawn from N.E.b.E. to S.W.b.W. The greatest depression, 3°.58, accompanies a wind from N.N.W., and the greatest elevation 3.61 occurs with a wind from S.S.W., giving a range of 7°.19.

That the variations that accompany the N. E. and West winds have different signs in the two series is partly owing to the proximity of these points to the line, which, in the earlier series, is found to separate the relatively warm from the relatively cold winds. Another cause of

disagreement is the fact that many winds reckoned, in the later series, as belonging to the N.E. group, blew from points, which, in the earlier series, were included in the N.N.E. and E.N.E. groups. A similar remark is applicable to the West winds.

In this table the annual mean results only are given, but from an investigation made for each half-year in three years, 1860—62, the following relations were found to exist :—

With the N.E. wind and West wind the temperatures were above the normal in some half years and below it in others, without reference to the season.

With the East and S.E. wind the temperature was above the normal in each winter and below the normal in each summer, and with winds from the South and S.W. the temperature was above the normal in each separate half-year.

In table V. we have the annual means of the diurnal changes in the temperature without reference to sign. For reasons before explained, the differences from which the means were derived are between 2 P.M. and 2. P.M. for the first six years, and between 6 A.M. and 6 A.M. in the years 1860, '61, and '62. The range in the numbers regarding them as comparable* from the greatest 6°.8 to the least 5°.4, differs little from that of the nine annual means of abnormal variation.

In table VI. the monthly and annual means of the diurnal changes of temperature are given for the earlier and later series separately and jointly. For both series the differences have been taken between 6 A.M. and 6 A.M. on consecutive days.

In both series, taken separately, the greatest diurnal change is in February, and the least in July. Taking the two series in combination, the greatest change is 9°.9 in February, and the least change is 3°.8 in July. The quarterly averages are 5°.3 in spring, 4°.1 in summer, 6°.5 in autumn, and 9°.3 in winter. The general annual mean being 6°.25.

It may be remarked that when the differences are taken from 2 P.M. to 2 P.M. the annual mean derived from the years 1854 to 1859 is 5°.83, and the range is systematically less in each separate year. On the average of the six years the greatest monthly mean difference

*The numbers derived from the earlier series are not strictly comparable with those from the remaining three years, inasmuch as the average value, when the differences are taken between 2 P.M. and 2 P.M. is about 0°.4 less than when the differences are between 6 A.M. and 6 A.M. This may be accounted for by the fact that 6 A.M. is an hour slightly more subject to irregularity of temperature than 2 P.M.

reckoned from 2 P.M. to 2 P.M. is 7°.4, and the least 4°.7. The quarterly averages being 5°.7 for spring, 5°.2 for summer, 5°.2 for autumn, and 7°.2 for winter.

In table VI. no distinction is made between the increasing and the decreasing changes of temperature, and it does not appear whether the changes of one sign are numerous and of small magnitude and those of the opposite sign few and abrupt, or whether the changes in either direction are on the average equal in number and magnitude. These questions have been examined in the case of the differences between 2 P.M. and 2 P.M. in the years 1854 to 1859, and the following are some of the results.

It appears that in eight months of the year there is a preponderance in the number of increasing changes of temperature, that throughout the year the temperature rises 54 times out of 100 days, and that the average value of an increasing change is 5°.4, and of a decreasing change 6°.3 nearly. The number of times out of a hundred days that the temperature rises and the average increase and decrease in the four seasons are as follows :—

	Number of increasing changes in a hundred.	Average Increase.	Average Decrease.
Spring	55	5°.2	6°.4
Summer	55	4°.7	5°.9
Autumn	54	4°.9	5°.6
Winter	51	7°.0	7°.5

Hence the descending changes of temperature are systematically more sudden at all seasons than the ascending changes.

In table VII. the annual mean changes of temperature between 6 A.M. and 6 A.M. on consecutive days, are given with their proper signs in eight groups corresponding to the resultant direction of the wind during the day in which the change took place. From the more complete tables from which table VII. is derived, it is found in the earlier series, that in every month with a resultant wind from N , N.W., and W. the temperature is lowered ; in every month with a resultant wind from S.W., S., S.E., and E. the temperature is raised, and that with a resultant wind from N.E. the temperature is raised in some months and lowered in others, the collective effect in the whole year being a rise of temperature with a N.E. wind. In the series, 1860 to 1862, the temperature is also lowered in all months with resultant winds f m N., N.W., and W. ; but with winds from other points, although

there is the general correspondence in the annual means exhibited in table VII., exceptions in one month or another occur for each of the other five points.

BAROMETRIC PRESSURE.

Table VIII. gives the mean abnormal variations of barometric pressure for the different years from 1854 to 1862 derived from six daily observations. The greatest annual mean is 0.193, the least 0 170, and the general mean for the nine years 0.183.

In table IX., designed to shew the monthly averages of the extent of the barometric abnormal oscillations, the annual distribution resembles in its general character that of the abnormal oscillations of temperature. The quarterly averages are 0.191 in spring, 0.118 in summer, 0.186 in autumn, and 0.231 in winter.

The diurnal distribution of the abnormal variations of the barometer are given in table X. In both series the most tranquil hour is 10 P.M. and the most disturbed hour 8 A. M. An examination of the hourly distribution in the separate months given by the earlier series, shewed that 8 A.M. was the most disturbed hour in ten months out of the twelve, the exceptions being February and December; and that the most tranquil hour was either 10 P.M. or midnight in every month but November, when the minimum was at 4 P.M.

Table XI. gives the mean abnormal variations of the barometer that accompany different directions of the wind.

According to the results furnished by the first seven years, the highest barometer accompanies a wind from N. N. E., and the lowest barometer one from S. W. In both series the barometer is above the normal when the wind is from N., N.E., E., S.E., and S., and below the normal when the wind is from S.W., W., and N.W.

In table XII. are given the annual means of the changes without regard to sign between the barometric pressures at like hours of consecutive days.

In table XIII. these differences are classified according to the months. The correspondence in the two series is on the whole tolerably close, the maximum occurring in either January or February and the minimum in either July or August. Combining the two series, and giving double weight to the first, the greatest monthly average change in twenty-four hours is 0.281 in January, and the least 0.121 in July, the annual mean being 0.198. The quarterly means

are 0.206 in spring, 0.126 in summer, 0.190 in autumn, and 0.270 in winter.

It has been found from the observations of 1854 to 1859 that on the whole the barometric pressure passes from one condition to another by gradations, of which those in which the pressure increases, are nearly equal in number and magnitude to those in which the pressure decreases, the average magnitudes of the ascending and descending changes being respectively 0.194 and 0.197.

From table XIV. in which the mean changes in the barometer, with their proper signs, between 6 A.M. and 6 A.M. on consecutive days, are arranged according to the resultant direction of the wind during the day, it is seen that in both series, the barometer rises, on the average of the year, when the resultant wind is from N., N.W., and W., and that it falls with a resultant wind from other quarters. It has been also found from both series that these statements hold true in nearly every month taken separately.

A comparison in the signs in tables XI. and XIV. corresponding to the several winds, brings out the fact that the same winds that accompany a relatively *high* barometer are for the most part those that accompany a fall, and that the winds that correspond to a *low* barometer commonly accompany a rise.

PRESSURE OF DRY AIR.

Tables XV., XVI. and XVII. give for each year, each month, and each hour respectively, the mean abnormal variations of what is commonly designated as the pressure of dry air.

The following are the quarterly means of the abnormal variations of the pressure of dry air, together with those of barometric pressure, both being derived from the years 1860 to 1862 :—

	Spring.	Summer.	Autumn.	Winter.	Year.
Dry Air....	0.215	0.184	0.211	0.258	0.217
Barometer..	0.191	0.128	0.175	0.233	0.183

The maximum and minimum are as follows :—

	Dry Air.	Barometer.
Maximum	0.282 in December.	0.257 in December.
Minimum......	0.167 in July.	0.114 in August.

From table XVII. a very faint trace of a diurnal period, better marked in summer than in winter, is observable, the mean digressions being slightly less at 10 P.M. than at 6 A.M. and 2 P.M.

From table XVIII., wherein the abnormal variations of the pressure of dry air with their proper signs are arranged according to the direction of the wind at the hour of observation, it is seen that the signs are the same as those for the barometer, excepting that the pressure of dry air with a N. W. wind is decidedly above the normal and with a South wind slightly below it.

Tables XIX. and XX. give for each of the three years, 1860 to 1862, and for each month on the average of the three years, the mean change in the pressure of dry air during twenty-four hours.

The average changes in the four quarters, together with those for the barometer, both derived from the same three years are as follows:

	Spring.	Summer.	Autumn.	Winter.	Year.
Dry Air	0.228	0.207	0.237	0.302	0.243
Barometer	0.197	0.137	0.192	0.273	0.199

Hence while the diurnal change in the pressure of dry air varies with the seasons in a manner similar to that of the barometer, the change is considerably greater for the former.

From table XXI it is seen that the pressure of dry air increases in twenty-four hours with a resultant wind from N., N.W. and W., and decreases with a resultant from any other quarter. This is found to be true for each month taken separately with eight exceptions only out of the whole ninety-six.

PRESSURE OF VAPOUR.

Tables XXII. and XXIII. give the abnormal variations of the pressure of vapour in each of the three years and for each month on the average of three years. The transition from month to month is not quite regular. The greatest monthly mean digression is 0.099 in August, and the least, 0.040, occurs both in January and March. The annual fluctuations in the average amount of the pressure of vapour and in the extent of its abnormal variations, are very similar in character, as may be seen from the annexed table, by which also it appears that the irregular variation averages about one-fourth of the whole pressure of vapour.

	Spring.	Summer.	Autumn.	Winter.	Year.
Pressure of Vapour	0.200	0.441	0.285	0.119	0 261
Variation	0.055	0.090	0.071	0.043	0.065

Table XXIV. shews that the maximum variation in the pressure of vapour is at 2 P. M., and the minimum at 6 A. M., which are also the

hours of the greatest and least pressure included among the six hours of observation.

The mean extent of the oscillations at 2^h and 4^h are found to be greater than at 10^h, 12^h, 18^h, and 20^h in every month but January and February, and in each quarter, excepting the winter.

From table XXV. it appears that the pressure of vapour is below the normal when the wind at the time of observation is from N., N.W., and W., and above it when the wind is from any other quarter. It has also been found that with winds from N., N.W., and W. the pressure of vapour is below the normal in every month, with two exceptions out of thirty-six, and that in every month with winds from the other points the pressure is above the normal, with seventeen exceptions out of sixty.

The mean changes of the pressure of vapour in twenty-four hours, for each of the three years, and for each month in the average of the three years, are given in tables XXVI. and XXVII.

The quarterly means given are 0.044 in spring, 0.087 in summer, 0.067 in autumn, and 0.042 in winter; the general mean being 0.060, which is slightly less than the general mean abnormal variation.

From table XXVI. it appears that a resultant wind from N., N.W., and W. is accompanied by a diminished pressure of vapour, and that with a resultant wind from any other quarter the pressure of vapour is increased. With very few exceptions this has been found to be true for each month taken singly as well as on the average of the year.

With a view of shewing more distinctly the shares taken by the pressures of dry air and of vapour in producing the varied conditions of the barometer that accompany the different winds; the abnormal variations of the barometric pressure and of the pressures of dry air and of vapour, as well as the changes between 6 A.M. and 6 A.M., corresponding to the eight principal points of the compass, have been collected in tables XXVII. and XXVIII.

RELATIVE HUMIDITY.

On the average of the three years the abnormal variation of relative humidity is 9.4, saturation being 100: the greatest monthly value is 12.3 in June, and the least 8.0 in December and January.

Of the six observation hours, 4 P. M. and 6 A. M. are the hours most subject and least subject to irregularity.

With winds from N.E., E., and S.E. the air is relatively damp, and with winds from W., N.W., and N. the air is relatively dry. The most damp wind is from the East and the most dry wind from N.W.; but the range is small, amounting only to 9.0.

The average change in humidity in twenty-four hours without regard to sign is 8.9, the greatest monthly change being 12.4 in June, and the least 7.3 in February.

The humidity increases in twenty-fours with a resultant wind from N.E., E., S.E., and S., and diminishes with a resultant from S. W., W., N.W., and N., the greatest increase of humidity being with a resultant wind from E., and the greatest diminution with one from N. W. The range between the E. and N. W. winds is, however, only 6.1.

It may be remarked with reference to the preceding paragraphs that the observations of three years are materials too scanty to justify our regarding as conclusive the results that relate to humidity.

CLOUDINESS.

If the compass be divided into four quadrants designated respectively by their middle points, the means of cloudiness found to accompany winds blowing from points included within these quadrants, together with their differences from the general mean, 59, were found from upwards of 13,000 observations in the years 1853 to 1859 to be as follows, the whole hemisphere being 100.

N. E. b. E.	S. E. b. S.	S. W. b. W.	N. W. b. N.
72	54	61	51
+13	−5	+2	−8

Mean Abnormal Variations of Temperature without regard to sign, or mean differences without regard to sign between the normal temperatures of the day and hour, and the observed temperature at the same day and hour, from 1854 to 1862 inclusive.

TABLE I.

Mean Abnormal Variations of Temperature, without regard to sign, for the different years.

1854.	1855.	1856.	1857.	1858.	1859.	1860.	1861.	1862.	1854 to 1862.
7°.1	6°.6	6°.2	6°.8	6°.5	6°.8	6°.4	6°.1	5°.9	6°.5

TABLE II.

Mean Abnormal Variations of Temperature, without regard to sign, for the different months.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
1854 to 1859	9°.4	10°.1	7°.9	5°.5	5°.1	5°.7	5°.5	4°.5	5°.9	6°.0	5°.8	8°.8	6°.7
1860 to 1862	8.4	8.8	6.9	5.5	5.7	4.7	4.5	4.6	5.5	6.1	4.8	8.2	6.1
1854 to 1862	9.1	9.7	7.6	5.5	5.3	5.4	4.8	4.5	5.8	6.0	5.5	8.6	6.5

TABLE III.

Half-yearly and yearly mean Abnormal Variations of Temperature, without regard to sign, for the six observation hours.

Toronto Astronomical Time.		2 *h.*	4 *h.*	10 *h.*	12 *h.*	18 *h.*	20 *h.*	2 & 4*h.*	10, 12, 18 & 20*h.*
	Winter.	7°.6	7°.4	7°.9	8°.1	8°.6	8°.4	7°.48	8°.25
1854 to 1859.	Summer.	5.9	5.8	5.1	5.2	5.1	5.1	5.90	5.13
	Year.	6.8	6.6	6.5	6.7	6.8	6.7	6.69	6.69
	Winter.	6.7	6.6	7.3	7.4	7.8	7.4	6.68	7.48
1860 to 1862.	Summer.	5.7	5.7	4.9	5.0	4.7	4.5	5.72	4.78
	Year.	6.2	6.2	6.1	6.2	6.2	5.9	6.20	6.13
	Winter.	7.3	7.1	7.7	7.9	8 4	8.1	7.22	7.99
1854 to 1862.	Summer.	5.9	5.8	5.0	5.2	5.0	4.9	5.84	5.01
	Year.	6.6	6.5	6.4	6.5	6.7	6.5	6.53	6.50

TABLE IV.

Abnormal Variations of Temperature, with their proper signs, arranged according to the direction of the wind at the hour of observation, from six daily observations.

Direction.	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.
1853–1859	−2°.80	−3°.18	−1°.81	+1°.37	+1°.73	+1°.18	+1°.79	+2°.28
1860–1862	−2.78	....	+0.02	....	+1.13	....	+1.35	....

Direction	S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W.	N.W.	N.N.W.	Calms.
1853-1859	+2°.89	+3°.61	+3°.45	−0°.73	−2°.18	−3°.17	−3°.54	−3°.58	+1°.33
1860-1862	+1.56	......	+4.21	......	+0.14	......	−2.27	......	−0.10

TABLE V.

Annual means of the changes, without regard to sign, between the temperatures observed at like hours on consecutive days in each of the years 1854 to 1862. The changes were taken from 2 P.M. to 2 P.M. in the years 1854 to 1859, and from 6 A.M. to 6 A.M. in 1860, 1861, and 1862.

Years.	1854	1855	1856	1857	1858	1859	1860	1861	1862
Changes.	6°.8	5°.6	5°.7	5°.4	5°.5	5°.9	5°.7	5°.9	6°.5

TABLE VI.

Monthly mean differences, without regard to sign, between the temperatures of the air at 6 A.M. on consecutive days.

	January.	February.	March.	April.	May.	June.	July.	August.	September	October.	November.	December.	Year.
1854 to 1859	10°.0	10°.0	6°.7	4°.9	4°.2	3°.9	3°.7	4°.2	6°.2	6°.8	7°.2	8°.2	6°.35
1860 to 1862	8.6	9.6	6.4	4.4	4.7	4.5	4.1	4.5	6.4	6.3	5.5	7.6	6.05
1854 to 1862	9.5	9.9	6.6	4.8	4.4	4.1	3.8	4.3	6.3	6.6	6.6	8.0	6.25

TABLE VII.

Mean differences, with their proper signs, between the temperatures observed at 6 A.M. on consecutive days, arranged according to the daily resultant direction of the wind in the same interval.

	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
1854 to 1859	$-3°.30$	$+1°.49$	$+3°.49$	$+4°.55$	$+3°.86$	$+2°.16$	$-2°.87$	$-4°.51$
1860 to 1862	-1.88	$+2.37$	$+4.02$	$+6.29$	$+3.90$	$+2.71$	-3.18	-4.50

Mean Abnormal Variations of Barometric Pressure, without regard to sign, or mean differences, without regard to sign, between the normal Barometric Pressure of the day and hour and the observed Barometric Pressure of the same day and hour, from 1854 to 1862.

TABLE VIII.

Mean Abnormal Variations of Barometric Pressure for the different years.

1854.	1855.	1856.	1857.	1858.	1859.	1860.	1861.	1862.	1854 to 1862.
0.196	0.180	0.175	0.189	0.175	0.185	0.193	0.184	0.170	0.183

TABLE IX.

Mean Abnormal Variations of Barometric Pressure for the different months.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
1854 to 1859.	0.249	0.215	0.223	0.196	0.151	0.126	0.121	0.119	0.162	0.183	0.228	0.225	0.183
1860 to 1862.	0.214	0.230	0.210	0.209	0.155	0.147	0.123	0 114	0.144	0.172	0.210	0.257	0.182
1854 to 1862.	0.237	0.220	0.219	0 200	0.153	0.133	0.122	0.117	0.156	0.179	0.222	0.236	0.183

TABLE X.

Yearly mean Abnormal Variations of Barometric Pressure for the six observation hours.

Toronto Astronomical Time.	2 *h.*	4 *h.*	10 *h.*	12 *h.*	18 *h.*	20 *h.*
1854 to 1859	0.187	0.182	0.175	0.177	0.188	0.191
1860 to 1862	0.184	0.180	0.178	0.179	0.185	0.187
1854 to 1862	0.186	0.181	0.176	0.178	0.187	0.190

TABLE XI.

Abnormal Variations of Barometric Pressure, with their proper signs, arranged according to the direction of the wind at the hour of observation, from six daily observations.

Direction.		N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.
Abnormal variations	1853 to 1859.	+.069	+.079	+.052	−.008	+.016	+.031	+.041	+.043
	1860 to 1862.	+.071	......	+.020	......	+.017	......	+.037	......

Direction.		S.	S.S.W.	S.W.	W.S.W.	W.	W.N.W	N.W.	N.N.W.	Calms
Abnormal variations	1853 to 1859.	+.016	−.057	−.115	−.079	−.061	−.043	−.017	+.019	+.030
	1860 to 1862.	+.009	......	−.114	......	−.076	......	−.005	......	+.030

TABLE XII.

Annual means of the changes, without regard to sign, between the Barometric Pressures observed at like hours on consecutive days. The changes were taken from 2 P.M. to 2 P.M. in the years 1854 to 1859, and from 6 A.M. to 6 A.M. in 1860, 1861, and 1862.

Years.	1854	1855	1856	1857	1858	1859	1860	1861	1862
Changes.	0.210	0.185	0.184	0.188	0.200	0.201	0.189	0.208	0.201

TABLE XIII.

Mean differences, without regard to sign, between the Barometric Pressures at 6 A.M. on consecutive days for each month.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
1854 to 1859.	0.280	0.253	0.257	0.217	0.160	0.126	0.110	0.128	0.151	0.168	0.248	0.273	0.198
1860 to 1862.	0.282	0.289	0.235	0.195	0.160	0.148	0.144	0.120	0.163	0.192	0.220	0.249	0.199
1854 to 1862.	0.281	0.265	0.250	0.210	0.160	0.133	0.121	0.125	0.155	0.176	0.239	0.265	0.198

TABLE XIV.

Mean differences, with their proper signs, between the Barometric Pressures observed at 6 A.M. on consecutive days, arranged according to the daily resultant direction of the wind in the same interval.

	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
1854 to 1859.	+.097	—.102	—.179	—.197	— 099	—.036	+.144	+.170
1860 to 1862.	+.076	—.137	—.196	—.178	—.130	—.089	+.142	+.183

TABLE XV.

Mean Abnormal Variations of the Pressure of Dry Air, without regard to sign, for each of the years 1860, 1861, and 1862.

1860.	1861.	1862.	Means. 1860 to 1862.
0.223	0.221	0.205	0.217

TABLE XVI.

Mean Abnormal Variations of the Pressure of Dry Air, without regard to sign, for the different months.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
1860 to 1862.	0.240	0.251	0.229	0.229	0.186	0.193	0.167	0.191	0.201	0.215	0.218	0.282	0.217

TABLE XVII.

Mean Abnormal Variations of the Pressure of Dry Air, without regard to sign, for each of the six observation hours.

Toronto Astronomical Time.	2 *h.*	4 *h.*	10 *h.*	12 *h.*	18 *h.*	20 *h.*
Winter	0.241	0.237	0.237	0.237	0.241	0.242
Summer	0.198	0.197	0.188	0.190	0.198	0.196
Year	0.220	0.217	0.213	0.213	0.219	0.219

TABLE XVIII.

Mean Abnormal Variations of the Pressure of Dry Air, with their proper signs, arranged according to the direction of the wind at the hour of observation.

	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calms.
1860 to 1862.	+ 0.101	+ 0.016	+ 0.005	+ 0.026	– 0.003	– 0.150	– 0.063	+ 0.036	+ 0.035

TABLE XIX.

Mean change, without regard to sign, between the Pressures of Dry Air observed at 6 A.M. on consecutive days for each of the years 1860, 1861, and 1862.

	1860.	1861.	1862.	1860 to 1862.
Mean Changes . .	0.233	0.247	0.250	0.243

TABLE XX.

Monthly mean differences, without regard to sign, between the Pressures of Dry Air at 6 A.M. on consecutive days.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November	December.	Year.
1860 to 1862.	0.310	0.321	0.258	0.224	0.201	0.219	0.209	0.194	0.234	0.237	0.240	0.275	0.243

TABLE XXI.

Mean differences, with their proper signs, between the Pressures of Dry Air observed at 6 A.M. on consecutive days, arranged according to the daily resultant direction of the wind in the same interval.

	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
1860 to 1862.	+0.096	–0.152	–0.240	–0.264	–0.189	–0.109	0.180	0.227

TABLE XXII.

Mean Abnormal Variations of the Pressure of Vapour, without regard to sign, for the years 1860, 1861, and 1862.

	1860	1861	1862	Mean 1860 to 1862.
Variations.	0.067	0.064	0.064	0.065

TABLE XXIII.

Mean Abnormal Variations of the Pressure of Vapour, without regard to sign, for the different months.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
1860 to 1862.	.040	.042	.040	.053	.072	.083	.087	.099	.095	.073	.046	.047	.065

TABLE XXIV.

Mean Abnormal Variations of the Pressure of Vapour, without regard to sign, for each of the six observation hours.

Toronto Astronomical time.	2 *h.*	4 *h.*	10 *h.*	12 *h.*	18 *h.*	20 *h.*
1860 to 1862.	0.071	0.070	0.064	0.063	0.061	0.062

TABLE XXV.

Mean Abnormal Variations of the Pressure of Vapour, with their proper signs, arranged according to the direction of the wind at the hour of observation.

	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calms.
1860 to 1862	—.028	+.006	+.015	+.015	+.013	+.039	—.010	—.037	—.005

TABLE XXVI.

Mean change, without regard to sign, between the Pressures of Vapour observed at 6 A.M. on consecutive days, for each of the years 1860, 1861, and 1862.

	1860	1861	1862	1860 to 1862
Mean change.	0.061	0.056	0.063	0.060

TABLE XXVII.

Monthly mean differences, without regard to sign, between the Pressures of Vapour at 6 A.M. on consecutive days.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
1860 to 1862.	.038	.043	.039	.041	.051	.091	.082	.088	.093	.065	.044	.044	.060

TABLE XXVIII.

Mean differences, with their proper signs, between the Pressures of Vapour observed at 6 A.M. on consecutive days, arranged according to the daily resultant direction of the wind in the same interval, from the years 1860 to 1862, inclusive.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
—.020	+.015	+.043	+.085	+.057	+.021	—.036	—.044

TABLE XXIX.

Annual mean Abnormal Variations of the Barometric Pressure, Pressure of Dry Air, and Pressure of Vapour, for the eight principal points of the wind's direction, derived from the three years, 1860, 1861, and 1862.

	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
(1) Barometer	+.071	+.020	+.017	+.037	+.009	—.114	—.076	—.005
(2) Dry Air................	+.101	+.016	+.005	+.026	—.003	—.150	—.063	+.036
(3) Vapour................	—.028	+.006	+.015	+.015	+.013	+.039	—.010	—.037
(2) + (3)............	+.073	+.022	+.020	+.041	+.010	—.111	—.073	—.001

TABLE XXX.

Annual means of the Diurnal Changes in the Barometric Pressure, Pressure of Dry Air, and Pressure of Vapour, that accompany the different resultant winds, from the years 1860, 1861, and 1862.

	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
(1) Barometer	+.076	—.137	—.196	—.178	—.130	—.089	+.142	+.183
(2) Dry Air................	+.096	—.152	—.240	—.264	—.189	—.109	+.180	+.227
(3) Vapour................	—.020	+.015	+.043	+.085	+.057	+.021	—.036	—.044
(2) + (3)............	+.076	—.137	—.197	—.179	—.132	—.088	+.144	+.183

TABLE XXXI.

Mean Abnormal Variations of Relative Humidity, without regard to sign, for the years 1860, 1861, and 1862.

	1860	1861	1862	Mean 1860 to 1862
Variation.	9.5	9.0	9.6	9.4

TABLE XXXII.

Mean Abnormal Variations of Relative Humidity, without regard to sign, for the different months.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
1860 to 1862.	8.0	8.7	10.0	11.1	11.8	12.3	9.5	8.2	8.3	8.4	8.1	8.0	9.4

TABLE XXXIII.

Mean Abnormal Variations of Relative Humidity, without regard to sign, for each of the six observation hours.

Toronto Astronomical time.	2 *h.*	4 *h.*	10 *h.*	12 *h.*	18 *h.*	20 *h.*
1860 to 1862.	11.3	11.9	8.6	8.2	7.4	8.8

TABLE XXXIV.

Mean Abnormal Variations of the Relative Humidity, with their proper signs, arranged according to the direction of the wind at the hour of observation.

	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
1860 to 1862.	—2.8	+2.6	+3.9	+0.9	—0.7	+0.3	—3.2	—5.1	+0.4

TABLE XXXV.

Mean change, without regard to sign, between the observed values of the Relative Humidity at 6 A.M. on consecutive days, for each of the years 1860, 1861, and 1862.

	1860.	1861.	1862.	1860 to 1862.
Mean change.	9.7	8.7	8.3	8.9

TABLE XXXVI.

Monthly mean differences, without regard to sign, between the observed values of the Relative Humidity at 6 A.M. on consecutive days, for the different months.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
1860 to 1862.	7.9	7.3	8.9	10.8	11.0	12.4	8.8	7.7	7.7	7.8	7.9	8.0	8.9

TABLE XXXVII.

Mean differences, with their proper signs, between the values of the Relative Humidity observed at 6 A.M. on consecutive days, arranged according to the daily resultant direction of the wind in the same interval, for the three years 1860, 1861, and 1862.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
−1.4	+0.8	+3.9	+3.3	+2.8	−0.4	−1.9	−2.2

THE PHYSIQUE OF DIFFERENT NATIONALITIES.

AS ASCERTAINED BY INSPECTION OF GOVERNMENT RECRUITS.

[*From a communication made to the Statistical Society of New York, by Dr. Wm. H. Thompson.*]

Some writers appear to take it for granted that the Saxon, the Celt and the German have in a measure deteriorated on American soil, especially as respects *physical* vigor. The causes which have given rise to these opinions are readily appreciable, for they lie on the surface. No one, I think, who has spent much time in Great Britain, the source of the bulk of our population, can fail to notice,

on returning, a considerable contrast in the appearance of the American from his British kindred, both in features and complexion. This consists more especially in the loss of fat in the cheeks and about the eyes, with a change in the shape of the mouth owing to early alteration of the teeth, and a seeming flatness of the chest causing an appearance of stooping, from anterior prominence of the shoulders. Indeed the American features are now as readily recognised abroad as those of the German or Frenchman, and he can by these alone be very generally distinguished from his English namesake.

That the American climate, therefore, has, in the lapse of two centuries or less, considerably modified the European type, is a fact which we think few can deny. What that change indicates—whether it is simply a stage in the process of acclimatization, or a positive loss of vitality in the race, is a question the importance of which cannot be exaggerated. In the whole kingdom of life no transplanting into a new soil occurs, without an apparent decline at first; but if a new and increased vigor is to be manifested, we must find the perennial root healthy and strong, though the early leaves may wither. The question is to be decided by the condition of the stock itself, and we think that it is precisely here that the observations which have given rise to such melancholy anticipations fail most strikingly. The impressions of a tourist on the complexion and appearance of a people are accepted as scientific data, and straightway conclusions are propounded, at whose vastness even an archangel might stand aghast.

But a great opportunity has arisen to substitute facts and observations for theories on this whole question. A test, than which nothing more complete could be devised, has been suddenly brought to bear, not only on the working of our institutions, the extent of our resources and the character of our people, but of their development in bone and muscle as well. The issue at stake in a tremendous contest has taken hold of the feelings of the entire nation, and sent thousands from every class of the population and every condition in life to undergo the hardships of the field.

And I would now beg leave to direct your attention to one particular aspect of this great event of the age, which I have myself been more especially called upon to note. Having had the honor of an appointment by his Excellency Governor Morgan, as medical examiner for the State of all recruits for regiments in the field mustered at the depot of New York city during the past summer, it occurred to me to take advantage of the opportunity for instituting observations on a number of points of medical interest and importance. In no other connection, as we have indicated, could there be afforded better facilities for such observations, since both city and country, every calling and pursuit, every degree of culture from the professor of Hebrew to the street cleaner, and every nationality which composes our present population, were most fully represented, while all presented themselves as healthy adults at the age of their fullest physical vigor. War certainly presents some singular aspects, for what else can be conceived that would bring about a procession of some 9,000 human beings in the original costume of Eden, in the hope of their being pronounced fit to go forth to shoot and be shot. But in no other way could all those artificial circumstances, which difference men from one another to such a degree, be so completely laid aside, and every race and condition appear in the equality of nature itself.

Of special interest also is the fact of the foreign-born population being represented in almost the exact proportions which they hold in the census tables, and these thousands "of the best blood of the colonizing stock" came up by the side of English and Dutch descendants of six generations on American soil. The majority of my observations related to matters more of a professional than public interest, but at the same time I noted carefully the bodily conformation of each recruit in such a way as would enable me to classify them into several degrees of physical development. These notes were taken at my dictation by a clerk whose services I was enabled to secure, and on summing up the results of my observations, I find that I can draw comparisons between the different nationalities, which I hope will be found, from the large number examined, to be true in their main conclusions.

From the middle of July to the 1st of October, 8,700 recruits presented themselves to me to be inspected. Of this whole number, 4,538 were Americans, 1,694 were Irish, 1,453 were Germans, 345 English or Scotch, 135 French, and 545 belonged to 26 other nations. From this it will be seen that the native Americans exceeded by about a hundred the sum total of all other nationalities. The proportion of foreigners is naturally greater in recruits from New York than any other city. The first subject which naturally presented itself was the bodily stature and general physical appearance of the various recruits. In stature, the American born ranked the highest, the English next, the Irish next, the Germans next, and the French last.

We now come to the actual physical conformation of the various nationalities as deduced from my observations. I found it at first somewhat difficult to lay down clearly defined rules of classification, and I therefore adopted a very general division into four classes, which were respectively termed Prime, Good, Indifferent, and Bad. Under the head "Prime," I included first, those who had a well-proportioned osseous system, (the groundwork of the personal figure), as shown by the shape of the skull, the bones of the thorax and pelvis, and the lines of the extremities. The shape of the joints, the shape of feet and hands, and the condition of the ligaments was especially noted. Secondly came a good development of the muscular system, especially those of the lower extremities, as the most reliable indication of the vigor of spinal nutrition. Under the term "Good,' were classed those who were then apparently healthy and strong, with more especially a good muscular development, but who did not eqnal the Prime in the development of the osseous system, from lack of lateral symmetry, bow legs, large joints, flat feet, etc. Under the head of "Indifferent" might be found good forms and tolerable muscular development, but who had tendencies to constitutional diseases, as well as a good many who may have had good constitutions originally, but had become deteriorated from various causes. Under the head "Bad" were such as had never been good nor ever would be so, from an originally vicious conformation.

The results of these observations are the following:

Of American-born Recruits, 47.5 per cent. had a prime physique; the Irish 35 per cent, and the Germans 40.75 per cent.

The per centage of Good Physique, was Americans, 36; Irish, 38; Germans, 38.5.

The per centage of Indifferent was Americans, 13.5; Irish, 19.5; Germans 19. The per centage of bad—Americans 3; Irish, 7.5; Germans 3 per cent. From this it will be perceived that the Americans show the highest rate of prime physique, the Germans next, and the Irish last. Of "Good," the Irish and Germans are nearly equal, and four per cent. more than the Americans. But this is owing to the excess of the latter in "Prime." These figures, therefore, confirm the estimates which we have already made which show that a great majority of the army is composed of American-born recruits. Of the Americans, 2,038 were from the country districts directly, and 2,500 were recruited from this city and Brooklyn.

Of "Indifferent," the Irish are one-half higher than the Germans, which last are 5½ per cent. higher than the Americans. Of the "Bad" the Irish are more than double the Americans and Germans, who in this respect stand alike. So far, therefore, these figures seem favorable to the American-born. But there are several considerations to be taken into account, which will, to a certain extent, modify the references to be drawn from them. In the first place the Americans were largely from classes of society, who from youth have been able to command better facilities in food, clothing, and shelter, than the classes from whom the immigrant population is derived. What an influence this must exert on physical development is sadly illustrated by the mortality returns of this city, which show that though the American population is not exceeded by the foreign, yet that seven children of foreign-born parents die in a year to one American child. Besides more than half the Americans were born and reared in country districts, and the difference which this fact causes may be shown by comparing among them the city and country recruits. Thus the proportion of "Prime" among city Americans was 42 per cent; country 58 per cent; of "Good," city, 40 per cent; country, 29 per cent; of "Indifferent," city, 14 per cent; country, 12 per cent; of "Bad," city, 4 per cent; country, 1 per cent. Another reason why the Irish are double the Americans in bad physique, seemed to be that they were often recruited for several Irish regiments, almost exclusively from the Sixth Ward. One of the most active recruiting stations being the Toombs Prison itself, and such specimens as occasionally presented themselves to our eyes and noses from those regions, could scarcely be surpassed by Macbeth's witches themselves.

Still these considerations do not affect the actual standing of the American recruits, for whatever the causes may be that have aided them, I feel safe in rating their physical development as of the highest order, and I have seen specimens of the armies of nearly all European, as well as Eastern nations. With the exception of a general loss of fat, I do not believe that there is another race that can show a larger proportion in the average population, of excellent osseous and muscular development.

We know it to be a frequent observation of tropical physicians, that the American sailor shows a greater power in resisting epidemics than his British comrade. We believe we can add to this our observation of the British soldier in the Crimea, and of the American soldier in the Peninsular campaigns, which have confirmed to our minds the old adage, that fat is not as tough as muscle.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—DECEMBER, 1863.

Latitude—43 *deg.* 39.4 *min. North.* *Longitude*—5 *h.* 17 *min.* 33 *sec. West.* *Elevation above Lake Ontario,* 108 *feet.*

Day.	Barom. at temp. of 32°. 6 A.M.	2 P.M.	10 P.M.	MEAN.	Temp. of the Air. 6 A.M.	2 P.M.	10 PM	ME'N	Excess of mean above Normal.	Tens. of Vapour. 6 A.M.	2 P.M.	10 P.M.	M'N	Humidity of Air. 6 A.M.	2 P.M.	10 P.M.	M'N	Direction of Wind. 6 A.M.	2 P.M.	10 P.M.	Resultant Direction.	Velocity of Wind. 6 A.M.	2 P.M.	10 PM	Resul't.	ME'N	Rain in Inches.	Snow in Inches.
1	29.854	29.665	29.550	29.6735	° 24.1	° 36.7	° 39.2	° 33.52	° + 2.73	.100	.155	.164	.142	.77	.71	.67	.73	S WbW	S WbW	S W	S 52° W	11.5	16.5	19.8	15.26	15.28	...	...
2	.436	.643	.912	.6892	40.7	32.7	26.2	33.15	+ 2.67	.223	.142	.110	.154	.87	.76	.77	.78	SWbW	N N W	W N W	N 61 W	15.8	19.8	5.2	9.09	11.22	...	...
3	.961	.849	.581	.7842	22.6	35.6	41.4	32.90	+ 2.82	.097	.134	.214	.152	.80	.65	.81	.78	N E	S E b E	S W b S	S	4.0	9.8	14.0	5.76	8.33	...	...
4	.478	.436	.662	.5388	40.3	51.5	36.3	42.33	+12.55	.219	.190	.193	.199	.87	.50	.90	.75	S W b S	W	N	S 81 W	7.4	28.0	4.8	7.88	9.03	...	...
5	.726	.850	30.113	.9223	33.1	25.5	19.0	24.78	— 4.58	.153	.098	.085	.110	.81	.70	.82	.79	N b W	N NW	N	N 19 W	1.5	20.8	2.0	9.75	10.07	...	Inp.
6	30.244	30.289	—	—	12.9	27.0	—	—	—	.057	.115	—	—	.73	.77	—	—	N b E	E S E	Calm.	N 71 E	4.8	1.5	0.0	1.82	2.83	...	...
7	30.215	30.128	30.024	30.1152	20.1	36.3	25.2	27.48	— 1.18	.091	.150	.122	.121	.85	.71	.90	.81	S E b E	S b E	Calm.	S 36 E	1.0	4.5	0.0	1.78	1.91	...	...
8	29.968	29.836	29.736	29.8308	28.4	39.8	35.6	34.07	+ 5.60	.134	.182	.167	.157	.86	.74	.80	.79	S E	SWbW	Calm.	S 55 W	4.0	2.0	0.0	2.24	2.62	...	...
9	.740	.897	30.109	.9332	34.2	26.6	14.7	24.27	— 3.88	.152	.098	.067	.106	.77	.68	.78	.77	W b S	N N W	N	N 17 W	8.8	19.2	14.0	13.41	14.17	Inp.	...
10	30.196	30.183	30.096	30.1535	1.0	14.3	21.2	13.78	—14.07	.036	.071	.092	.068	.76	.85	.81	.79	N E b N	N E b N	E b S	N 84 E	3.0	6.2	11.3	8.48	9.72	...	0.2
11	29.903	29.725	29.590	29.7278	20.1	28.4	33.1	28.22	+ 0.57	.091	.134	.174	.139	.85	.86	.92	.88	N E	E b S	E	S 89 E	17.8	4.8	2.8	4.39	4.69	0.040	Inp.
12	.648	.606	.520	.5898	32.7	37.8	37.8	36.18	+ 8.83	.180	.217	.226	.207	.97	.95	.99	.96	Calm.	E b N	N E b E	N 65 E	0.0	8.8	8.8	6.80	6.91	0.920	...
13	.358	.234	—	—	41.7	44.6	—	—	—	.255	.283	—	—	.96	.96	—	—	N E	N N E	N E b E	N 50 E	3.8	2.0	6.0	6.63	7.38	0.455	...
14	28.886	28.789	.137	28.9645	37.8	42.8	27.3	35.05	+ 8.08	.226	.232	.111	.187	.98	.84	.74	.88	E N E	SW bW	W	S 84 W	17.8	20.3	30.0	15.04	21.41	0.460	0.1
15	29.522	29.678	.961	29.7375	23.7	27.3	24.8	24.72	— 2.05	.098	.103	.091	.098	.77	.69	.68	.74	W	W	NW b N	N 81 W	25.5	28.0	11.8	17.41	17.96	..	0.1
16	30.106	30.145	30.107	30.1285	17.9	21.4	18.6	19.25	— 7.32	.085	.077	.083	.079	.87	.67	.82	.76	Calm.	N E bN	N E	N 51 E	0.0	0.8	11.4	8.46	8.88	...	0.5
17	29.806	29.446	29.168	29.4492	21.2	30.9	32.4	28.17	+ 1.80	.105	.171	.176	.151	.93	.99	.96	.96	E N E	E b N	E b N	N 81 E	21.0	21.7	16.0	16.21	17.51	0.130	1.5
18	.265	.270	.370	.3138	31.3	27.3	21.9	26.30	+ 0.13	.152	.126	.090	.123	.86	.84	.77	.84	S W	W S W	W b S	S 73 W	13.0	19.0	12.5	13.07	13.49	...	Inp.
19	.455	.538	.601	.5440	18.3	18.3	21.9	18.37	— 7.70	.080	.080	.099	.078	.81	.81	.84	.77	W b N	W b N	W N W	N 71 W	14.5	5.0	11.0	10.91	11.52	...	0.1
20	.713	.688	—	—	8.2	23.2	—	—	—	.035	.081	—	—	.54	.65	—	—	NW bN	W N W	W	N 73 W	1.5	23.0	0.5	5.44	5.65	...	Inp.
21	.706	.563	.595	.6220	16.9	23.3	20.1	20.15	— 5.63	.084	.116	.105	.101	.90	.93	.97	.92	Calm.	Calm	N E b E	N 45 E	0.0	0.0	8.5	4.82	5.03	...	0.3
22	.692	.708	.807	.7380	14.7	15.8	7.1	11.75	—13.93	.072	.065	.053	.064	.84	.73	.88	.85	N E b N	N E b E	N b E	N 26 E	5.5	1.5	4.5	3.88	4.11	...	Inp.
23	.846	.877	.934	.8933	7.5	19.0	17.9	14.25	—11.32	.058	.072	.079	.068	.93	.70	.80	.82	N N E	NW bN	N N W	N 23 W	2.2	9.0	10.0	7.77	7.83	...	...
24	.984	.993	30.035	30.0103	12.2	23.7	16.1	16.85	— 8.63	.065	.076	.082	.072	.86	.59	.90	.77	N	Calm.	N	N 3 E	9.0	0.0	3.7	2.85	2.88	...	...
25	30.019	30.012	—	—	19.0	29.5	—	—	—	.085	.136	—	—	.83	.83	—	—	Calm.	E b S	N E b N	N 73 E	0.0	4.5	3.5	2.78	3.13	...	...
26	30.021	29.942	29.809	29.9150	22.6	33.1	30.2	28.75	+ 3.45	.111	.130	.157	.131	.92	.69	.93	.83	Calm.	Calm.	E N E	N 40 E	0.0	0.0	0.5	0.88	0.93	...	1.0
27	29.785	.836	—	—	30.9	33.4	—	—	—	.164	.157	—	—	.94	.82	—	—	N b E	E N E	E b N	N 63 E	3.0	5.5	14.0	9.74	10.08	Inp.	0.3
28	.497	.164	.175	.2642	27.3	33.4	37.0	32.68	+ 7.53	.139	.187	.183	.171	.94	.98	.84	.92	E N E	E	S W b S	S 61 E	22.5	17.0	17.5	6.61	14.60	0.515	1.5
29	.259	.282	.460	.3435	34.2	35.6	32.7	33.98	+ 8.82	.187	.160	.165	.166	.95	.77	.88	.85	S W b S	S W	S WbW	S 59 W	13.5	20.5	5.0	14.17	14.52	Inp.	Inp.
30	.634	.806	.995	.8268	30.9	30.6	26.2	28.88	+ 3.72	.157	.144	.124	.140	.90	.85	.87	.87	S WbW	W b S	N W.	N 81 W	9.0	13.0	5.0	7.39	9.49	...	...
31	.934	.573	28.987	.4267	24.8	32.4	38.1	32.13	+ 6.95	.120	.169	.195	.169	.90	.91	.85	.92	N E	E	E	S 82 E	9.8	19.5	17.8	14.24	18.10	0.410	1.5
M	29.7207	29.6766	29.6936	29.6975	24.56	30.00	27.00	27.00	— 0.09	.124	.134	.131	.129	.87	.71	.84	.83	....	....	....	....	8.10	11.36	8.77	......	9.40	2 960	7.1

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR DECEMBER, 1863.

NOTE.—The monthly means do not include Sunday observations. The daily means, excepting those that relate to the wind, are derived from six observations daily, namely at 6 A.M., 8 A.M., 2, 4 and 10 P.M., and midnight. The means and resultants for the wind are from hourly observations.

Highest Barometer..........................30.313 at 10 a.m. on 6th } Monthly range =
Lowest Barometer ....28.769 at 1 p. m. on 14th } 1.544 inches.

Self-registering Thermom.
- Maximum Temperature .... 53°4 on p.m. of 4th } Monthly range =
- Minimum Temperature .... –1°5 on a.m. of 10th } 54°9
- Mean maximum Temperature .... 34°00 } Mean daily range =
- Mean minimum Temperature .... 20°70 } 13°30
- Greatest daily range ......28°5 from a.m. to p.m. of 10th.
- Least daily range............ 2°0 from a.m. to p.m. of 22nd.

Warmest day .... 4th... Mean temperature.......... 42°33 } Difference = 30°58.
Coldest day .... 22nd... Mean temperature......... 11°75 }
Maximum { Solar.................................. 69°2 on p.m. of 4th } Monthly range =
Radiation. { Terrestrial.......................... —7°5 on a.m. of 10th } 76°7
Aurora observed on 0 night, viz.,—
Possible to see Aurora on 10 nights; impossible on 21 nights.
Snowing on 17 days, depth 7.1 inches; duration of fall, 55.8 hours.
Raining on 10 days, depth 2.960 inches; duration of fall 75.2 hours.
Mean of cloudiness = 0.72; below average 0.03.
Most cloudy hour observed, 8 a.m; mean = 0.76; least cloudy hour observed, 4 p.m.; mean, = 0.69.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
2093.11	1193.09	2341.36	3130.37

Resultant direction N. 41° W.; Resultant velocity 1.61 miles per hour.
Mean velocity..................................9.40 miles per hour.
Maximum velocity .... 32.8 miles, from 8 to 9 p.m. on 14th.
Most windy day ......14th............Mean velocity, 21.41 miles per hour. } Difference =
Least windy day ...26th.............Mean velocity, 0.93 ditto. } 20.48 miles.
Most windy hour .... 1 to 2 p.m...............Mean velocity, 11.17 ditto. } Difference =
Least windy hour ...7 p.m. to 8 p.m..........Mean velocity 8.02 ditto. } 3.15 miles.

1st. Mild, Wind in violent squalls.—4th. Mild day, Wind high and squally.—5th. Morning mild, temperature descending rapidly, night keen.—9th. Morning mild, night clear and keen, great change of temperature. 11th. Slight Snow and Rain most of the day; Foggy at midnight.—12th. Foggy till 9 a.m.; Constant heavy Rain from 0.30, p.m.—13th. Slight Rain till noon; Foggy at 2 p.m.—14th. Stormy day; Steady Rain till 5 p.m.; Snowing slightly from 8 p.m.—15th. Stormy day; Wind high with occasional flurries of Snow.—17th. Stormy day; Rain, Hail or Snow most of the day.—20th. Perfect Lunar Halo at 8 p.m.—28th. Stormy, mixture of Rain, Hail or Snow nearly all day.—29th. Slight Rain 6 to 7 a.m.; particles of Snow from 8 a.m.; Windy.—31st. Mild day, Wind high, Snowing from noon to 4 p.m. and Raining from 6 p.m. to 4 a.m. of 1st Jan. 1864.

COMPARATIVE TABLE FOR DECEMBER.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above aver'ge (26.1)	Max. observed	Min. observed.	Range.	No. of days.	Inches	No. of days.	Inches	Resultant. Direction.	Resultant. V'y.	Mean Force or Velocity.
1840	24.3°	— 1.8°	41.0°	— 4.4°	45.4°	3	Inap.	18	...	...	...	....
1841	28.7	+ 2.6	45.5	+ 2.4	43.1	7	6.600	5	...	...	...	1.33lbs.
1842	24.7	— 1.4	40.3	+ 3.8	36.5	3	0.880	17	...	...	...	0.60
1843	30.0	+ 3.9	41.1	+ 2.7	38.4	6	1.040	8	8.1	...	...	0.53
1844	28.2	+ 2.1	48.9	— 0.8	49.7	6	Imp.	6	4.2	...	...	0.40
1845	21.1	— 5.0	37.6	— 2.7	40.3	2	Imp.	12	4.7	...	...	0.70
1846	27.5	+ 1.4	49.2	+ 3.7	45.5	5	1.215	9	6.0	...	...	0.57
1847	30.1	+ 4.0	50.0	+ 6.6	43.4	7	1.185	8	6.8	...	...	0.35
1848	29.1	+ 3.0	49.1	+ 0.6	48.5	7	2.750	7	16.5	S 83° W	1.12	5.44mls.
1849	26.5	+ 0.4	41.3	— 5.2	46.5	5	1.840	12	9.6	N 82° W	2.56	6.23
1850	21.7	— 4.4	48.3	— 9.7	58.0	2	0.190	18	29.5	N 44° W	2.93	7.40
1851	21.5	— 4.6	43.8	—10.5	54.3	6	1.075	15	10.7	N 82° W	4.00	7.37
1852	31.9	+ 5.8	51.0	+13.9	37.1	7	3.995	10	20.1	S 69° W	1.03	6.54
1853	25.3	— 0.8	42.2	— 5.2	47.4	4	0.625	13	22.3	N 35° W	2.39	4.98
1854	21.9	— 4.2	41.8	— 5.9	47.7	5	0.590	12	17.2	N 44° W	4.30	8.56
1855	26.8	+ 0.7	45.9	— 2.1	48.0	6	1.845	10	29.5	S 88° W	5.29	11.38
1856	22.9	— 3.2	41.2	— 9.1	50.3	6	1.790	20	16.3	S 87° W	4.62	11.56
1857	31.9	+ 5.8	45.6	+ 5.7	39.9	7	3.205	14	9.0	N 89° W	2.51	6.84
1858	27.4	+ 1.3	43.6	+ 5.0	38.6	11	1.657	18	10.4	N 18° W	1.66	9.36
1859	17.9	— 8.2	54.8	— 3.3	58.1	3	1.035	23	37.4	N 53° W	4.29	10.77
1860	24.0	— 2.1	38.5	— 7.0	45.5	3	1.362	21	23.5	N 62° W	4.66	10.14
1861	31.1	+ 5.0	55.1	+ 5.7	49.4	6	0.560	8	6.8	N 72° W	3.50	7.96
1862	28.8	+ 2.7	50.0	— 2.3	52.3	5	1.945	8	10.4	N 73° W	3.17	7.58
1863	27.0	+ 0.9	51.5	+ 1.0	50.5	10	2.960	17	7.1	N 41° W	1.61	9.40
Results to 1861.	26.11	...	45.26	—0.72	45.98	5.3	1.545	12.9	14.66	N 69° W	2.97	8.18
Exc. for 1863.	+ 0.89	...	+ 6.24	+ 1.72	+ 4.52	+ 4.7	+ 1.415	+ 4.1	— 7.56	....	......	+ 1.22

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—JANUARY, 1864.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 m. 33 s. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resul't. Direction.	Velocity of Wind.					Rain in inches.	Snow in inches.
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M	2 P.M	10 PM	ME'N		6 A.M	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N	6 A. M.	2 P. M.	10 P. M.		6 AM.	2 PM.	10 P.M.	Re-sul't.	ME'N		
					°	°	°	°	°												°							
1	28.917	29.238	29.552	29.2795	33.1	8.2	—5.5	9.77	—15.45	.167	.052	.024	.071	.88	.82	.70	.78	s w b s	w s w	w s w	s 66 w	24.5	30.2	27.4	28.19	28.37	...	0.2
2	29.648	.740	.808	.7372	—6 6	—0.5	—0.5	—2.40	—27.60	.025	.035	.035	.032	.81	84	.84	.83	w s w	w s w	w s w	s 67 w	27.5	30.5	22.2	24.22	24.29	...	...
3	.803	.729	—	—	2.8	12.5	—	—	—	.042	.062	—	—	.83	.80	—	—	w s w	w s w	w s w	s 65 w	17.0	17.5	15.0	15 54	15.57	...	...
4	.835	.827	.756	.8083	10.7	14.7	11.1	12.52	—12.62	.064	.067	.060	.065	.92	.78	.83	.86	w s w	w b s	N b w	N 40 w	4.5	1.5	5.2	3.11	4.71	...	2.0
5	.456	.541	.697	.5738	12.2	1[illegible].8	16.5	15.37	— 9.77	.071	.078	.076	.075	.94	.88	.83	.87	N	w N w	s w b w	s 88 w	11.5	1.0	13.5	7.59	10.72	...	3.0
6	.781	.839	30.065	.9158	13.2	15.1	11.1	12.47	—12.68	.071	.062	.060	.062	.91	.71	.83	.81	sw b w	w s w	N w b N	s 81 w	13.0	17.2	8.5	7.12	9.99	...	...
7	30.102	30.004	29.863	.9772	2.8	15.4	11.8	9.40	—15.73	.043	.070	.063	.057	.83	.81	.86	.82	N b w	w b s	w	s 89 w	1.8	5.0	10.6	3.84	4.33	...	Inp.
8	29.720	29.641	.603	.6458	8.6	12.9	11.4	11.08	—14.05	.053	.063	.062	.060	.82	.80	.85	.84	Calm.	w	s w	s 69 w	0.0	16.0	7.8	10.25	10.81	...	Inp.
9	.589	.549	.491	.5490	7.5	8.2	11.3	9.95	—15.18	.054	.052	.071	.060	.88	.82	.85	.86	w s w	s w b w	w s w	s 59 w	15.0	20.5	17.6	17.38	17.48	...	...
10	.532	.568	—	—	13.6	17.6	—	—	—	.067	.076	—	—	.83	.79	—	—	s w	s w	s w b w	s 50 w	18.8	10.6	11.0	13.88	13.90	...	...
11	.507	.414	.458	.4535	15.0	19.0	17.9	16.95	— 8.10	.075	.072	.072	.073	.87	.70	.74	.78	s w	w s w	w s w	s 59 w	12.8	16.8	7.5	11.87	12.00	...	...
12	.383	.192	.185	.2460	20.8	29.8	30.9	27 42	+ 2.33	.090	.133	.127	.116	.81	.80	.73	.77	s w	s w b s	s w b w	s 47 w	17 2	20.5	8 4	12.93	13.06	...	...
13	.245	.221	.407	.3098	29.1	34.9	27.0	29.83	+ 4.75	.133	.151	.121	.133	.82	.75	.82	.80	s w	s w b w	w s w	s 59 w	12.0	10.5	3.4	7.82	8.21	...	...
14	.513	.462	.454	.4723	21.5	33.8	34.5	29.58	+ 4.48	.095	.152	.181	.141	.82	.78	.91	.84	s w bw	E b s	E	s 83 E	0.5	8.0	3.0	3.68	4.07	...	2.0
15	.302	.312	.648	.4390	33.4	30.9	23.0	28.37	+ 3.27	.171	.141	.092	.128	.89	.81	.73	.79	E b s	w b N	w	s 89 w	3.5	17 5	16.0	10.01	11.67	..	3.0
16	.788	.776	.766	.7798	19.0	27.7	24.4	25.02	+ 0.02	.085	.106	.103	105	.82	.69	.78	.77	w s w	s w	s w	s 45 w	0.2	15.0	3.4	6.66	6.69	...	...
17	.714	.618	—	—	28.4	36.7	—	—	—	.134	.171	—	—	.86	.78	—	—	Calm.	s s w	s w b s	s 31 w	0.0	8.5	6.5	5.57	5.64	...	0.5
18	.760	.669	.551	.6452	33.4	33.1	28.0	31.22	+ 6.25	.163	.145	.139	.149	.85	.76	.90	.85	Calm.	N b E	N b E	N 8 E	0.0	10.5	16.0	10.15	10.33	...	4.0
19	.334	28.910	.181	.1563	29.1	27.3	21.5	25.37	+ 0.18	.141	.133	.102	.121	.87	.89	.88	.88	N b E	w b N	N w	N 48 w	13.5	27.5	29.5	21.54	24.78	...	10.0
20	.501	29.713	.888	.7308	17.9	25.5	17.6	19.37	— 5.48	.085	.104	.076	.086	.87	.75	.78	.81	N w b N	w N w	N b E	N 36 w	20.0	6.0	3.0	4.13	4.66	...	...
21	30.010	.988	.919	.9678	8.2	23.7	25.1	18.95	— 5.83	.052	.105	.116	.092	.82	.82	.86	.83	N b E	Calm.	s w	s 46 w	4.5	0.0	11.5	6.14	6.91	...	0.5
22	29.740	.676	.768	.7257	29.5	32.4	21.9	27.85	+ 3.08	.150	.153	.099	.135	.92	.83	.84	.87	s w	s w	s w b w	s 55 w	18.0	17.0	5.0	9.14	9.25	...	0.1
23	.736	.397	.339	.4793	20.8	36.3	39.6	33.45	+ 8.78	.103	.193	.202	.168	.92	.90	.83	.86	Calm.	s s w	w b s	s 51 w	0.0	9.5	5.5	7.24	7.68	Inp.	...
24	.282	.127	—	—	35.6	41.4	—	—	—	.187	.196	—	—	.89	.75	—	—	w s w	s s w	s w b w	s 44 w	5.0	3.5	4.0	5.21	5.37	...	...
25	.256	.353	.084	.2355	30.6	38.5	36.3	34.90	+10.32	.152	.173	.193	.170	.89	.74	.90	.84	Calm.	s w b s	s	s 50 w	0.0	7.2	6.2	2.91	5.08	...	...
26	.185	.491	.430	.3728	38.1	36.0	34.9	36.02	+11.53	.179	.137	.176	.162	.77	.65	.86	.76	w s w	N b w	s b w	N 65 w	4.8	6.0	2.5	3.37	5.37	Inp.	...
27	.395	.466	.608	.5067	32.7	41.7	34.2	36.38	+12.03	.173	.184	.160	.168	.92	.69	.81	.78	s w b w	Calm.	s w	s 73 w	1.5	0.0	2.5	1.28	1.49	...	...
28	.638	.572	.721	.6502	28.4	42.5	41.0	36.82	+12.52	.134	.199	.200	.174	.86	.73	.78	.79	N w	Calm.	N b w	N 11 w	2.5	0.0	9.6	3.51	4.23	..	...
29	.882	.910	.936	.9203	36.3	29.8	24.8	29.85	+ 5.65	.168	.096	.120	.125	.78	.58	.90	.75	N N E	E b N	E N E	N 59 E	7.0	10.2	11.4	9.65	9.77	0.020	...
30	.819	.662	.703	.7288	23.0	29 1	28.0	27.13	+ 3.03	.106	.148	.139	.133	.86	.92	.90	.89	E N E	E N E	N E	N 60 E	9.4	15.0	7.0	8.46	8.78	0 225	1.0
31	.838	.877	—	—	27.3	30.9	—	—	—	.139	.157	—	—	.94	.90	—	—	Calm.	E b N	E	N 81 E	0.0	4.0	17.5	11.35	11.54	0.920	Inp.
M	29.5785	29.5601	29.6108	29.5887	21.09	25.45	22.34	22.79	— 2.01	.108	.116	.110	.110	.86	.78	.83	.82	....	....	....	....	10.26	11.72	8.58	......	10.22	1.165	26.3

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR JANUARY, 1864.

NOTE.—The monthly means do not include Sunday observations. The daily means, excepting those that relate to the wind, are derived from six observations daily, namely, at 6 A.M., 8 A.M., 2 P.M., 4 P.M., 10 P.M., and midnight. The means and resultants for the wind are from hourly observations.

Highest Barometer . . . . . . 30.102 at 6 a.m. on 7th. } Monthly range=
Lowest Barometer . . . . 28.910 at 2 p.m. on 19th. } 1.192 inches.

Self-registering Ther.:
- Maximum temperature . . . 44°2 on p.m. of 24th } Monthly range=
- Minimum temperature . . . . —9°0 on a.m. of 2nd } 53°2
- Mean maximum temperature . . 29°58 } Mean daily range=12°07
- Mean minimum temperature . . 17°51 }
- Greatest daily range . . . . . . 26°9 from a. m. to p. m. of 21st.
- Least daily range . . . . 2°8 from a. m. to p. m. of 18th.

Warmest day . . . 28th...Mean Temperature . . . 36°82 } Difference=39°22.
Coldest day . . . 2nd...Mean Temperature . . . —2°40 }
Maximum Radiation { Solar (Vacuum) . . . . 106°0 on p. m of 26th } Monthly range=
{ Terrestrial . . . . —13°5 on a. m. of 2nd } 119°.5
Aurora observed on 0 nights. Possible to see Aurora on 11 nights; impossible on 20 nights.
Snowing on 14 days; depth 26.3 inches; duration of fall, 65.5 hours.
Raining on 5 days; depth, 1.165 inches; duration of fall, 16.4 hours.
Mean of cloudiness=0.67; below average, 0.05. Most cloudy hour observed, 8 a.m; mean=0.77; least cloudy hour observed, 4 p.m.; mean=0.60.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
1351.28	2678.33	827.94	5094.59

Resultant direction, S. 73° W.; Resultant Velocity, 6.00 miles per hour.
Mean velocity 10.22 miles per hour.
Maximum velocity 33.4 miles, from 1 to 2 p.m. on 2nd, and from 6 to 7 p m. on 19th.
Most windy day 1st—Mean velocity 28.37 miles per hour. } Difference 26.88.
Least windy day 27th—Mean velocity 1.49 miles per hour. }
Most windy hour, noon to 1 p.m.—Mean velocity, 12.36 miles per hour. } Difference
Least windy hour, 4 to 5 a.m.—Mean velocity, 7.95 miles per hour. } 4.41 miles.
1st, 2nd, and 3rd.—Continued storm of wind from 4 a.m. of 1st to 1 a.m. of 4th; temperature piercing and keen.—13th. Perfect solar halo at 1 and 2 p.m.—14th. Solar halo 3 to 4 p.m.—16th. Perfect lunar halo 8 to 9.30 p.m.—18th. Heavy snow storm from 3 p.m. of 18th, continuing to 8 p.m. of 19th; wind high and squally, and snow drifting furiously.—20th. Solar halo at 9 a.m.; lunar corona 9 and 10 p.m.—22nd. Lunar halo at 10 p.m.—24th. Lunar corona at 9 p.m.—25th. Solar halo during the forenoon.—30th. Stormy; rain and snow intermixed 7 a.m. to midnight.—31st. Heavy storm of rain from midnight to 6 a.m. of 1st February.

The temperature of the first eleven days of this month was uniformly cold, being, up to the 11th inclusive, 14°58 below the normal; the latter part of the month was comparatively warm.

COMPARATIVE TABLE FOR JANUARY.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean	Excess above Average, (45°5).	Maximum observed.	Minimum observed.	Range.	No. of days.	Inches.	No. of days.	Inches.	Resultant. Direction.	Resultant. Velocity.	Mean Force or Velocity
1840	17.0	— 6.6	40.6	—13.8	54.4	4	1.395	11	...	...	...	...
1841	25.6	+ 2.0	41.7	— 4.1	45.8	2	2.150	14	...	...	...	0.36 lbs
1842	27.9	+ 4.3	45.8	1.3	44.5	4	2.170	9	...	...	...	0.78 "
1843	28.7	+ 5.1	54.4	1.5	52.9	6	4.295	12	14.2	...	...	0.69 "
1844	20.2	— 3.4	44.6	— 7.7	52.3	7	3.005	11	24.9	...	...	0.70 "
1845	26.5	+ 2.9	43.0	— 3.4	46.4	5	Imp	9	22.7	...	...	0.70 "
1846	26.7	+ 3.1	41.2	0.3	40.9	5	2.335	10	6.0	...	...	0.55 "
1847	23.3	— 0.3	42.6	— 2.2	44.8	7	2.135	5	7.5	...	...	1.09 "
1848	28.7	+ 5.1	51.5	—12.0	63.5	7	2.245	8	7.1	N 82 W	2.03	5.82 ms
1849	18.5	— 5.1	40.1	—15.2	55.3	4	1.170	10	9.2	N 63 W	3.06	6.71 "
1850	29.7	+ 6.1	46.3	10.6	35.7	5	1.255	8	5.2	N 37 W	0.69	5.80 "
1851	25.5	+ 1.9	43.2	—12.8	56.0	4	1.270	10	7.8	S 77 W	3.26	7.69 "
1852	18.4	— 5.2	37.3	— 7.0	44.3	0	0.000	19	30.9	N 68 W	3.14	7.67 "
1853	23.0	— 0.6	40.9	— 6.6	47.5	1	0.290	6	7.5	N 27 W	2.52	6.34 "
1854	23.6	0.0	45.2	— 4.3	49.5	7	1.275	11	7.5	N 77 W	2.44	6.91 "
1855	25.9	+ 2.3	48.2	— 4.7	52.9	5	0.525	13	23.3	N 73 W	1.91	7.26 "
1856	16.0	— 7.6	33.1	—12.1	45.2	0	0.000	14	13.6	N 75 W	5.24	10.69 "
1857	12.8	—10.8	34.6	—20.1	54.7	3	Inap	16	21.8	N 70 W	4.96	10.31 "
1858	30.0	+ 6.4	45.8	7.5	38.3	6	1.152	11	4.0	N 71 W	2.33	7.40 "
1859	26.4	+ 2.8	41.5	—26.5	68.0	6	1.449	19	16.4	S 81 W	3.17	8.76 "
1860	23.4	— 0.2	45.4	— 5.1	50.5	6	0.740	16	8.7	N 89 W	6.09	9.37 "
1861	19.9	— 3.7	34.5	— 7.0	41.5	4	0.685	23	20.6	N 86 W	2.92	9.30 "
1862	21.7	— 1.9	42.8	— 1.9	44.7	5	0.115	19	27.4	N 26 W	2.69	8.83 "
1863	28.1	+ 4.5	44.6	—11.2	55.8	10	1.122	17	20.6	N 61 W	1.13	7.23 "
1864	22.8	— 0.8	42.5	— 6.6	49.1	5	1.165	14	26.3	S 73 W	6.00	10.22 "
Results to 1864.	23.61	...	42.86	—6.52	49.38	4.8	1.331	12.6	15.15	N 77 W	2.92	8.02
Exc. for 1864.	—0.82	...	— 0.36	—0.08	— 0.28	+ 0.2	— 0.166	+ 1.4	+ 11.15	...	...	+ 2.22

THE

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THE CANADIAN JOURNAL.

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ON ERRATA RECEPTA, WRITTEN AND SPOKEN.

BY THE REV. DR. SCADDING,
LIBRARIAN TO THE INSTITUTE.

(Read before the Canadian Institute, April 2nd, 1864.)

In treating of *Errata Recepta*, written and spoken, I shall confine myself principally to specimens of such as are formal, verbal, and phraseological. By formal, is meant those that are involved in the present FORMS of our letters and numerical symbols.

Errata Recepta, in notion and opinion, would be too wide a field, although a legitimate one here, so far as science is concerned, for it is no doubt one of the functions of this and similar Institutions to detect and remove out of the way, so far as shall be practicable, the phantasms,—the *idola,* as Lord Bacon would say—the vulgar errors as Sir Thomas Browne would phrase it,—which still are the plagues of human knowledge.

I use the title *Errata Recepta,* however, with no feeling that a crusade should be proclaimed against the matters in question, but simply to express that while they can now no longer be said to be wrong, they are nevertheless *per se* erroneous.

I might have said "established errors" in English, but this would have been saying too much;—it would have implied that there were things to be deplored and amended. All this we give up when we adopt the designation *Errata Recepta.* We at once confess them to be what they are.

Moreover I had the less scruple in venturing on this title, because the two words Errata Recepta—besides conveying briefly a particular shade of meaning—are both of them almost as familiar to us as English, the one being seen appended, unfortunately, to most printed books; and the other being associated in the well-known phrase by which the common edition of the Greek Testament is indicated, viz., the *Textus Receptus.*

Some of these peculiar usages in our written and spoken English are the astonishment of foreign scholars. They would puzzle many natives, were they suddenly called upon for the *rationale* of them. We have been taught them in our childhood, as so many dogmas, and we use them without thought. We pass them about like well known coin, of which we have no need to read the inscription; we trace them on our luxurious note-papers and in our account books, and their familiar look is no more suggestive of farther research than the ancient but handy quill perhaps, with which we have written them down.

Errata Recepta arrange themselves into numerous classes. (1) There are those that have arisen from the modifications of form in letters and numerical symbols. (2) There are some that appear in the shape of contractions and abbreviations. (3) There are many that have arisen from the Anglicising of foreign words, especially French, Italian, and German. (4) There are some that spring from the vernacularising of unfamiliar expressions—forcing them to say something that shall, at least, seem to convey an idea. (5) Then we have *errata recepta* which arise from wrong etymologies and from misprints. (6) There are some that spring from grammatical misconceptions and confusion in logic, as where the general is put for the special, and the special for the general. (7) Some are variations in the significance of terms, through the lapse of time. (8) We have *errata recepta* in the quantity or time of vowels in the syllables of derived words. (9) We have *errata recepta* in the nomenclature of persons, places, and things. (10) We have *errata recepta* in regard to the drift of certain popular proverbs or sayings.

I. *Errata Recepta* in letters and numerical symbols:

1. Letters.

To begin at the very beginning—with the elements themselves of words—the alphabet itself: what is this, in modern languages at least, but a series of *errata*—departures from original forms and intentions? *Errata Recepta* now, which there is neither need nor desire to correct. The mind fond of analysis, is, nevertheless not disinclined to recover the original forms, where it is possible to do so; and dwells with some interest on the idea that A, for example, is the head of an ox, only inverted; that Alpha, *i.e. Aleph*, is *ox*, and survives in that sense in *Eleph-as, i.e. Aleph-as*, elephant, that animal being designated in early unscientific days as a *bos*, somewhat in the same way as we call the great amphibious creature of the Nile a horse. That B, *beta*, is *beth*—a house—a hut—two wigwams, in fact, now, when you lay the letter on its face. And let it be at once well understood, that the attitudes and postures of letters have been almost infinitely varied. The Easterns generally (the users of Sanskrit excepted) write from right to left; the Westerns (the Etruscans excepted) from left to right: each turning the character accordingly. Hence we must often reverse letters before we can trace their identity. The scribes of intermediate races or tastes, wrote sometimes one line one way, and the next line the other way,—reversing perhaps the letters, as they reversed the direction of the reed. Others, again, arranged their words vertically—column-wise—like the modern Chinese.

From these and other like causes, it is not sufficient even to reverse the letters: we must, in certain instances, lay them on their face —lay them on their back—sustain them at uncomfortable angles— and humour them in other ways, discreetly and patiently, if we would trace the connection between them and their reputed congeners or originals. It is thus that we may, perhaps, at length detect that not only does *aleph* betoken an ox, and *beth* a booth; but that G (*i.e.* hard *c*), is a camel's head and neck; D, a triangular tent door-way; E, a hand in a certain dactylological posture; F *(bau)*, a hook or tent-pin; H, a garth, perhaps a temenos, or sacred enclosure; I (J and Y), again, a hand in proper position; as is also K (C); L, an ox-driver's goad or whip; M, rippling water, the element of its neighbour, N, which is a fish; O (connected with *ayin*), the human eye; P, the mouth seen in profile; Q, the ear; R, the head (also seen in

profile), the occiput, as distinguished from the face; S, the teeth seen in front; T, a kind of dancing cobra; U (V), a hook or tent-pole, as said for F; X, a combination of K and S; Y (as J), a hand in right position; Z, a barbed hook, for catching fish.

We cannot, of course, be sure that we thus track our letters to their prototypes; but human instincts everywhere developing themselves in an analogous way, we can easily conceive that all alphabets are pictorial in their origin; that they represented objects to convey an idea either of the objects absolutely, or of the sounds which the objects represented were supposed to symbolize. What is, in fact, the meaning of *litera?* It is something delineated or drawn *(lino);* the idea conveyed also by *γράφω*, which is to *pencil* or *draw*—though allied to *γλάφω* and *γλύφω*, to hew or carve, as *scribo*, to write, is to *scalpo* and *sculpo;* and the English *write* is to *writan*, properly to cut or engrave, and *wrotan* to plough or root up.

Symbols inscribed by sharp instruments, are strictly not letters (*literæ*) but characters, *χαράκτηρες*—from *χαράσσω*—which expresses "scratching," by its very sound. So that in the rude symbols of our Indians, in the canoes, wigwams, and school-boy-fashion figures of men and animals, charcoaled with a burnt stick, or indented with a flint-arrow point on a sheet of birch-bark, we have the veritable *literæ* and *characteres* — the *elementa elementorum* — the simplest forms and originals into which all letters and characters are to be resolved. Examples of the same also, were those sketches on cotton cloth, of the ships, horses, and artillery of Cortez, made by the Mexican Chiefs (1519), for the purpose of giving to Montezuma an idea of the power of the fatal invader.

Interesting specimens of picture-records *in transitu* to letters, may be seen in the beautiful inscription-tablets of Copan and Palenque, represented by Stephens, in his work on Central America. The Chinese and Japanese characters still bear on the face of them the appearance of being sketches of objects, although now conventionally rendered. And the Egyptian phonetic symbols and hieroglyphics, with which we are all more or less familiar, are very slightly disguised. Of these, the enchorial or demotic characters are declared to be modifications.

We can have little doubt, then, that the Chaldaic and Phœnician characters, and with them, for the most part, the Greek and the Latin,—and, through these, the European letters generally have their origin in pictures and sculptures.

When now, in addition to the deliberate drawing and engraving of records on durable substances, there arose the practice of writing with the reed on the papyrus-rind or skins, the celerity of execution which the impetuosity of human thought demands—and demands still in vain, in spite of the assistance of stenography—produced further modifications in letters, until a cursive or script style was formed, which became particularly beautiful in the Greek. What the cursive or script Latin character was we have no means of knowing precisely. We may be sure that Cicero had some convenient and rapid method of securing thought as it wells up within the brain: that he did not make his memoranda in capitals. We may conclude that the familiar Roman script has been in some measure preserved in the traditional styles of the old professional transcribers, who did not always execute their tasks in uncials, but produced MSS. like the Medicean Virgil of the fifth century, in a kind of round hand, which, under the influence of certain peculiar predilections, converted itself, in some nations, into the so-called black letter. This round hand of the *Librarii* was reproduced in the early printed books, in what we call *Italic*, the next remove from the script, in which, in the time of Aldus Manutius, (1516), for example, not prefaces merely, and dedications, but whole volumes were printed. Our present so-called Roman characters, the capitals excepted, are apparently a compromise between this ancient script or Italic, and the black letter or Gothic.

The modern alphabet, then, both as written and printed, is seen to be the result of a series of departures farther and farther from its primitive types—*errata*, indeed, but *errata* which we now willingly describe as *recepta* and no longer *corrigenda:* for as our national speech itself has attained its acknowledged terseness and point by a succession of free clippings in its parts and forms,—so its nimble servitors, the letters, by disencumbering themselves of much that once seemed essential, and was essential, have attained to an efficiency which if not complete is most convenient.

This simplicity of form, involving distinctness, is highly to be esteemed aud carefully guarded. English printers of late have been bringing back the style of type, both Roman and Italic, in vogue a century and a half ago, but which had nearly fallen out of ordinary use. A certain feeling of incongruity is at first experienced at meeting with the advanced ideas of the present day in a garb associated in the mind with many obsolete notions of the reign of Anne and the first Georges, and we are moved for a moment to imagine that the

art of printing is "regressing,"—to coin a word at least as good as its correlative and opposite—and we think it strange that any art at this era should "regress." But we soon see that the exquisite legibility secured by the round openness of even the smallest sized character in this style of printing will account for its return to public favour. We have also here, perhaps, a visible sign of a begun reaction against the loose un-Addisonian English, of which, as prevalent in certain quarters, Trench and Alford have been for some time complaining. A lately established clever journal entitled "*The Realm*," is wholly printed in the style referred to: its advertisements, all in beautiful clear brevier and diamond, have the air of paragraphs in the "*Gentleman's Magazine*" in Johnson's day.

In connexion with movements apparently retrograde, we may refer to the rather extravagant mediævalism which threatened a few years ago to render monuments and inscriptions unintelligible to the mass. It was especially enamoured of intricate initial letters, with wide-gadding, low-trailing appurtenances, covering an undue proportion of the page or legendal riband. This was a passing foible in a certain class; but it has left traces too durable in a number of works of art, in glass, metal and stone, which, although in themselves, in many an instance, exquisitely significant, yet fail to interpret themselves, as such monuments ought to do, to the eye and mind of the general public.

A collection of all the alphabets, serious and facetious, which have been designed of late years for ornamental and quasi-ornamental purposes, in magazines, advertisements, and books in general, would be exceedingly curious. "*The Builder*" every week throws out an ingenious and graceful initial idea. In some recent numbers of that periodical there have been beautiful developments of such ideas in representations of imaginary ornamental iron work. Over-intricate illuminated capitals continue to be amusingly and very cleverly caricatured by "*Punch*."

But to return from a digression. It is not many years since Lord Palmerston considered the deterioration of form in English cursive script to be an evil so great and so extended as to call for formal condemnation. Since his memorable dictum on this subject, a good deal of attention has been given in public offices and schools to the essential forms of the script letters; and it is now not unfashionable for signatures to be legible. The plain unaffected autographs of the Prince of Wales and Duke of Newcastle will be remembered.

That there may be no exception to the general return of the letters to a condition of propriety and truthfulness, one erratum in the delineation of the capital G may be worth pointing out and marked *corrigendum*. It is seen sometimes as if it had taken a leap in the air, and there been detained, whereas its bulky form should rather be at rest, down among its lesser fellows, with its distinctive but very subordinate little cedilla (so to call it) dropping below the general line. Capital Y is also sometimes seen, in like manner, unduly exalted. Its loop is simply a mark of difference between it and the letter U, and is not to be taken to represent the stem of the printed capital. Capital Q in script has irrecoverably departed from its essential type. Its beautiful circle is destroyed, and the very sub-ordinate little mark, which here again was simply to be diacritical, is flourished out into great conspicuousness. On the whole Q which used numerally to be worth 90, has degenerated into a large 2.

One more *erratum*, also certainly to be marked *corrigendum*, and I close my remarks on the modifications undergone by the letters.

Since our adoption in money-matters of the decimal system, the time-honoured but never-to-be-forgotten £. s. d. have withdrawn a good deal from the public view. About them there was little mistake. It may be remarked as curious that whilst *denarii* were closely associated with the idea of military pay, being the *stips* which formed the *stipend* of the soldier, the term "soldier" itself sprung out of *solidus*, an enduring trophy of success in some strike on a large scale, although after all, again, it is to *solidus* we owe our *sou i.e. sol.*

But what means the symbol $? It ought to be more self-interpreting than it is. An Egyptian or Chinese linguist might detect in it "honesty the best policy"—the upright man standing firm in the midst of a serpentine tortuosity, and resolving so to earn his dollar. Sometimes in script he is seen to incline—to be almost overthrown in the coil. We have here, however, nothing of this sort, but another of our *errata recepta*. The curve which looks like an S in this character is properly no S. It should be made in the reverse way. It will then be seen to constitute, with the vertical or verticals around which it twines, a kind of double P—a character which reads P whichever way it stands This dual P is the initial of the Spanish name of the coin which we call a *dollar*, viz., *Peso*, which is literally *pensum*, all but identical with *pondus*, or *pondo, i.e.*, our *Pound*: so that strangely enough our £, which denotes the same thing, viz., *Libra*, a

pound weight, would have answered, at least, as well as $ to represent "dollar." It is manifest that the most rational abbreviation would have been a simple D. And this we occasionally see at the head of Canadian and United States figures in English papers, in the absence probably of the usual symbol in the printing office. In some United States papers this character is seen cut in the right way. Would it not be found universally so in the Mexican papers?

On the *erratum receptum* in the word *dollar* itself, I shall remark in the proper place.

Were D employed for Dollar, it might receive the usual mark of contraction across its stem, as in £, ℔, &c. Had the symbol $ been an abbreviation of *Scudo,* it would have borne this mark transversely. But the silver coins, which we have named *dollars,* were not *Scudi*—were not associated in any way with Italians or their language, but wholly with the Spaniards and their language, in which they are known only as *Pesos.* In the symbol $ rightly formed, then,—which in reality is PP ingeniously monographed into one character, denoting the plural of *peso,* as MSS. denotes the plural of MS.—we have an interesting little historical monument of the early relations of this continent to the native land of its first possessors.

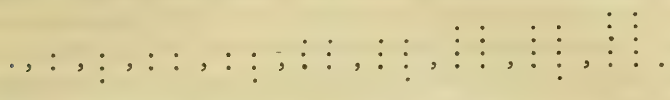
2. We next proceed to consider the Numerals from the point of view selected in this paper. (*a*) And 1st of the Roman Numerals.

The Roman Numerals present some examples of our *errata recepta.* The symbol for ten (X), if not a pictorial representation of the ten fingers outspread, is a conventional mark for ten separate tallies or strokes with a score drawn obliquely across them; whilst V (five) is the half of X, or else one hand expanded; or according to some it is an Etruscan five inverted. The symbol for *fifty,* L, is in reality ⅃, the Etruscan symbol for 50 inverted. D for 500 is really no D, but the half of C I Ɔ written also as an ellipse with its minor axis drawn, a symbol said to be also Etruscan, and denoting 1000, the initial probably, like M for *mille,* of the Etruscan word for that sum. On the principle that IV = 5—1, XL = 50—10, &c.

(*b*) And next of the Arabic Numerals.

Could we compare our Arabic numerals with their native prototypes and these again with their originals, we should see that here also we have a group of our *errata recepta*—of symbols answering their purpose as letters do, albeit they have departed far from their first condition. The first condition of these numerals, however, I think, was

not pictorial, but an arrangement of points shewing the numbers to be named. Somewhat thus:



These groups of points rapidly made, and each respectively connected together by a tracing of the calamus as it passed quickly from one dot to the next, may be conceived of as developing at last into our present Arabic numerals, the line connecting the points denoting also perhaps the order which the eye of the enumerator would swiftly follow.

This line itself may have been suggested by the accidental marks left by readers in the act of calculation. The so-called nailed letters in inscriptions are formed by light straight lines connecting bold punctures which mark out the general form of each character. This process of course produces a set of letters that are angular. In an interesting alphabet of the time of the Seleucidæ (about B.C. 250) the characters are marked out by an increased number of dots, with light lines connecting them, forming the letters called *perlées* by the French, from their *beaded* appearance. In these the angles are converted into curves in such letters as B and O. In a similar manner the numerals formed from the dots of computation speedily had their angles converted into curves, approximating thus to the flowing forms of our present cyphers; just as in rapid writing, the angular capitals also become at length the so-called round hand or cursive script.

The symbol for seven, about which on this hypothesis a difficulty may present itself, is either a combination of the written 6, with a connected point below for *plus* one; or an adaptation of the Greek *zeta* which, though standing sixth in the present Greek alphabet, is in notation the symbol for 7, one letter, *bau, i.e.* the digamma or *f*, having been disused as a letter, though retained as a symbol for 6. It will be noticed also that the final cypher has the value of *ten*, which may help to render rational the notation 10, 20, 30, &c.

I am aware of the theory that the original elements of the Arabic numerals were strokes or tallies, corresponding in number with the quantities indicated, productive also, in the first instance, of a set of square or angular characters. As their origination in points was independently conceived, and is at least equally probable, the supposed proeess has been briefly detailed. It may here be added that al-

though we call our numerals Arabic, they agree more closely in form with the Sanskrit than they do with the present Arabic.

With the revival of the type of the reign of Queen Ann, there has been a return also to the forms of the numerals then in vogue—forms which in some Offices, for some purposes, had never been disused.

For the sake, apparently, of producing evenness and compactness of line,—a praiseworthy object were we still in the habit of writing only in capitals—great liberties had been taken with the relative magnitudes of numerals by scriveners and type-founders—until the historical contour thereof had been sadly interfered with. Figures high and low, long and short, have been by those unphilosophic artists confounded, and made by a kind of Procrustean treatment to touch parallel limits at top and bottom. But clearly there is as much impropriety in making written figures all of a height, as there would be in doing so with the written letters.

The numerals, then, as they have been rendered of late in the *Saturday Review*, and numerous other notable publications, simply reassert the forms of which without authority they had been deprived; and although seniors will, as is their wont, not readily interrupt a custom learnt in childhood, young arithmeticians will prefer to adopt the revived method, and construct figures as well as letters in accordance with their *rationale*. Thus it will not be long before in schools it will be the practice to make 1's, 2's and 4's neither above nor below the general line of a series of words or figures (with the exception of 4 which extends a little way below); whilst in relation to the general line 6's and 8's will be written with the upper half above it, and 3's, 5's, 7's, 9's, with the lower half below it.

In the Procrustean treatment of figures described above, the symbol for "four" lost its essential form. Whilst being unnaturally stretched to reach the altitude of 8, its main stem snapped, and was ever afterwards simply indicated by a mere touch of the pen across what had been the base of a very perfect little triangle.

Symbols Algebraical and Geometrical are generally modern, and so have not had time to vary much from their first intention. They too are mildly pictorial, taxing the imagination but little. The *minus* sign is the track left by the part withdrawn; the *plus* is the obliteration of this, and so its opposite. In the symbol for division the severed parts have shrunk up into two points. A square is a square, a parabola is a parabola, and so on, But in the rapid execution neces-

sary at modern examinations we see the modification begin which shews us how letters and figures have arrived at their present forms. The "rune" for root ($\surd$) appears to be a written *r* exaggerated and rent asunder to gain room for the index of the quantity sought. The symbol peculiar to the Integral Calculus ($\int$) is a relic of the *fluents* of Newton.

The Zodiacal and Planetary signs have become considerably disguised. Aries, Taurus, Gemini, Sagittarius, Aquarius, and Pisces still speak, in some manner, for themselves. But it requires the aid of an acute imagination to see a crab in *Cancer*, a lion in *Leo*, a virgin (*query* Proserpine, the Kora) with the ears of wheat in *Virgo*, the scales in *Libra*, a scorpion in *Scorpio*, a piscicaudal goat in *Capricorn*.

In Saturn we dimly discern the *falx* of Chronos; in Jupiter Jove seated with the eagle at his feet; in Mars the shield and spear; in Venus her mirror; in Mercury his caduceus; in Ceres her sickle; in Pallas the gilded spear-head of Athené; in Juno her peacock in its pride; Earth, Uranus, Sun, and Moon are self-interpreting. Vesta is a picture confessed, of her ἑστία with the eternal fire thereon.

If planets are still to be represented by symbols, the invention of man is threatened with exhaustion, for asteroids are discovered in almost every year. They now amount to seventy-two.—The ascending and descending Node (☊, ☋) is a dragon, having apparently the geometric caterpillar's habit of progression.

There is nothing of the picturesque about the notation in Music. Sounds and sentiments are interpreted to the eye by bold points at various altitudes in respect to a system of horizontal lines, by spacings and slurs, and a number of arbitrary marks.

II. I arrive at *Errata Recepta* that appear in the shape of contractions and abbreviations.

1. And (first) of contractions.

There are conventional contractions which in themselves are rational enough; but in some instances we have been taught to use them so early, that we live for many years without detecting that they are anything more than mere symbols.

It has been perhaps not an uncommon experience to use for some years *cwt*, *dwt*, for hundredweight, pennyweight, without realizing their intrinsic composition.

The character denoting "and"—by how many of us was *per se*, as associated with this, the first Latin unconsciously learnt?—employed especially in the contraction for *et cetera*, has in modern manuscript and typography lost its organic form. This is reappearing now in the revived type before referred to. In Macmillan's Treasury Series, and in Cassell's new edition of Shakspeare, we see it again printed *Et* (*Etc.*) Although in rapid writing we do not expect this form to be restored, it is quite proper that we should know what it is that we write down when we execute the spirited flourish which occasionally at the end of a sentence symbolizes the indefiniteness conveniently concealed by it.

On old English coins the "et" has converted itself into a character like a "Z." Thus on a coin in the cabinet of the Canadian Institute is read, EDWARD. D. G. REX. ANGL. Z. FRANC. D. HYB.

This pretended *z* is one of the favorite *sigla* of the scribes. We have it in *viz*. for videlicet, in *oz*. for ounces, and in the symbols for drachms and scruples—where what are apparently *z*'s are simply flourishes of contraction. In V for *versicle*, R for *response*, and R again, for *Recipe*, a slight stroke across a portion of the letter gives the hint of abbreviation.

Domes-Day Book is full of such clerical abridgments. These so-called *sigla* became at an early period such a source of misunderstanding in MSS. that Justinian forbade their use in legal documents.* A very common note of contraction, long retained in English books, was a circumflex for the omission of *m* or *n*; as *cômunicatiô* for *communication*. Hence has arisen our *Co.* for *Company*. *No.* for *number*, is the French *numéro*. *Do. ditto*, is Italian for *dictum* "aforesaid." Titular initials are sometimes wrongly written and pointed. The LL. for the plural *Legum* will be thus seen divided by a period. In Macmillan's Magazine, not long since, L. L. O. O. P. for *Literarum Orientalium Professor* was given without comment, the error being

* Vide Justinian. *Codex. Lib. I. Tit. xv. iii.* 22. Eandem autem pœnam falsitatis constituimus et adversus eos qui in posterum leges nostras per siglorum obscuritates ansi fuerint conscribere. Omnia enim, id est, et nomina prudentium, et titulos et librorum numeros, per consequentias literarum volumus, non per sigla manifestari: ita ut qui talem librum sibi paraverit, in quo sigla posita sunt, in qualemcunque locum libri vel voluminis, sciat inutilis se esse codicis dominum: neque enim licentiam aperimus ex tali codice in judicium aliquid recitare, qui in quacunque suâ parte siglorum habet malitias. Ipse autem librarius, qui eas inscribere ansus fuerit, non solum criminali pœna, secundum quod dictum est, plectetur; sed etiam libri æstimationem in duplum dominus reddat, si et ipse dominus ignorans talem librum vel comparaverit, vel confici curaverit, quod et antea à nobis dispositum est, et in Latinâ constitutione et in Græcâ quam ad legum professores dimisimus.

considered perhaps too manifest to require remark. There is a tendency of late years—natural enough—to convert into plain English, the Academic titles, which were once supposed to adhere for life only in Latin, having been conferred in that learned dialect. Hence, we have now M.A., B.A., the English forms of A.M., A.B.—D.M. for M.D., has not yet appeared. Why not?

Divinity for *Theology*, (as *Divinitas* for *Theologia*) is an English solecism without any continental or classical authority. Hence have arisen our D.D. and B.D., as representing the Academic designations, common to all the old historic Universities, S.T.P., S.T.B. (*Sacrae Theologiae Professor......Baccalaureus.*)

The three initial R's are notorious: the four P's are not so well known. In John Heywood's drama (temp. Hen. VIII.) so entitled ("The Four P's") they seriously denote Palmer, Pardoner, Potticary, and Pedlar.

The *y* in the humorously-revived Pepysian "*ye*" for "the," is no *y*, but the Anglo-Saxon character for *th*. This make-shift for a disused letter appears *passim* in the early printed books, and old copies of the English Bible. It is admitted in the modern Polyglots of Bagster for the purpose of gaining space, so as to make the matter in the pages of the several versions respectively correspond. Y*r*, y*t*, y*m*, &c., are also common contractions of *their*, *that*, *them*, &c.; the *e*, *r*, *t*, &c., ought to be placed over the *y*.

2. We come now (secondly) to abbreviations, I mean abridged words, as *errata recepta*.

We all know how unallowable the abbreviation of words is, in letters and finished compositions, although in references, foot-notes, indices, business-reports, medical prescriptions, and a few other similar memoranda, the practice for convenience sake *is* permitted.

There is a tendency, in some degree, to employ these abridgments as complete words. We hear of *consols*. In the familiar language of Algebraists and Geometricans such abbreviations are not uncommon. Among booksellers we hear such barbarisms as 12mo's, 32mo's. Lawyers will tell you of *fi. fa.*'s. Musicians speak of *sol-fa-ing*.*

* Guido Aretino (A.D. 1020) observed, that in a certain chant for a hymn in honour of John the Baptist, the voice ascended in regular gradation upon the first syllable of each half line. To represent the sounds at these points, he adopted the first syllables of the half-lines in the following stanza:

Ut queant laxis *re*sonare fibris *Mi*ra gestorum *fa*muli tuorum *Sol*ve polluti *la*bii reatum,
Sancte Johannes!

For *ut*, *do* was afterwards substituted; and *si* was added.

All crafts, I suppose, have similar technical shortenings. In the political arena we see, if we do not hear, *Rep. by pop.** There is a tendency in such abridged terms to become at length actual words. Our language exhibits a few examples of terms which, originating in abbreviations, have in the course of time become legitimised, although in most cases they have not divested themselves of a certain taint of vulgarity. A hundred years ago, *mobile* (excitable, fickle) was a cant term for the populace. The complete phrase, either founded on some such expression as that of Cæsar, in regard to the Gauls (B. G. 4. 5.) "Galli sunt in capiendis consiliis mobiles,"—or obliquely glancing at the much sought for, but never found, "perpetuum mobile"—was "mobile vulgus." This *mobile* was curtailed at length into our familiar word *mob*, followed at first by the period of contraction, but afterwards written without any such distinction, and so it has passed into the language. Again; *Rhubarb* is now a very respectable word,—representing an equally respectable thing—whether drug or esculent. It is properly, however *Rha. Barb.* manifestly an apothecary's abbreviation of either *Rha Barbaricum*, or *Rheum Barbarum*. *Incog.* and *infra dig.*, have almost lost, in familiar language, their actual character. *Nem. con.* and *crim. con.* are not very ambiguous. We might venture to write *philomath* without a mark of abbreviation. By a kind of synecdoche of the first syllable for the whole term we have made out of *cabriolet*, *Hackney*, and *Hochheimer*, *cab*, *hack*, *and hock*. From *Grogram* (*grossa grana*, a coarsely woven material) and *Geniévre* (the French corruption of *Juniperus*—further anglicised by us into *Geneva*)—have come the names of two unmentionable liquids. *Cit.* once passed for citizen; but the modern *Gent.* has not yet succeeded in being recognized as *Gentleman;* nor his *pants* as *pantaloons;* nor his *nobs* as *nobiles*. *Fib.* for *Fabula* is one more abbreviation from the Latin. *Pi* or *pie*, denoting certain old Ecclesiastical rules, is the first syllable of *πί-ναξ*, the Table or Index, which detailed them. Type in *pie*, is type that must be re-arranged—put back into the *πί-ναξ* or case. *Pica* is *litera pica-ta*—letter pitch-black. *Magpie* is properly, as given in Shakspeare, *maggot-pie*, i.e. *pica morosa*, the whimsical *Pie*. *Sub.* for subaltern in the army and elsewhere; *Spec.* for speculation at the Exchange; *phiz.* for physiognomy, in the

* To the "foreign" reader it may be necessary to say that a certain dangerous reef running right across the lake of Canadian politics is thus named. The full form of the appellation is "Representation by Population."

photographic studios; *pos.* for positive, and *mem.* for memorandum, in the office of the Military Secretary, would be all taken as pretty intelligible English. The Germans seem to have adopted the prenomen *Max* for Maximilian. *Cur* has been seriously derived from *curtail*—a hound supposed to be disqualified for the noble chase by caudal abbreviation. *Cheap* is *Cheapside.* Is not *chap* the *chapman* with whom we are transacting business?

At the University, the *hoi polloi* are the *poll; optimes* are *ops;* sophisters are *sophs;* the *domini*—the heads of houses and other magnates—are the dons, *i.e.*, the doms; a vice-chancellor or vice-president is occasionally the *vice*, a term which would have been grievously misunderstood by frequenters of Mysteries and Moralities—and which ought, if anything, to be *vi-ce;* but that, although the correct thing, would sound nearly as bad. At Oxford, Demies are *demi,* i.e., *semi-communarii,* a sort of inferior fellow-commoners. The writers in "Blackwood," by an affectionate and not inelegant prosopopeia sometimes speak of their organ or magazine as *Maga.*

My specimens of words formed in a reverse way, by taking terminations instead of initial syllables, are not so numerous. *Drawing-*, for *withdrawing-room, story* for *history,* are not very striking; and it may be doubted that *brick* is *im-brec.* For the rest, take *cates* from *deli-cates; wig* from *periwig,* an anglicism for *perruque; bus* from *omnibus; bill* from *li-bell;* and finally, *copus,* from *episcopus,* a beverage in certain colleges at Cambridge.*

The few words said to be due to the initials of other words are all doubtful.

Maccabæus, the surname of the Jewish hero, B.C. 168, is attributed to the initials of the Hebrew words which signify "Who among the gods is like unto thee, Jehovah!" AERA has been said to denote "Annus erat, regnante Augusto," although, more probably, it was originally "The Bronzes;" as we sometimes say "The Marbles," meaning the Arundel or other marbles in citing authorities for dates.

* Better known perhaps as Bishop; not peculiar, however, to Cambridge or England. When Hieronymus Jobs, a German Student, was asked by his examiner in Theology, *Quid est episcopus*? he replied, "an agreeable mixture of sugar, pomegranate juice, and red wine." See Mr. Brooks' late Translation of the Jobsiad, a Germ. poem, temp. 1784. The same young gentleman defined "Apostles" to be, "Tall jugs in which wine and beer are kept in villages."

Hip, the thrice-repeated exclamation which precedes the cheer of onset or victory, is *Hierosolyma est perdita!* and should on this supposition be *Hep!* It was the cry heard in German cities when the unfortunate Jewish quarter was to be assailed. *News* has been derived, scarcely in earnest, it is to be imagined, from the initials of the four "airts," N, E, W, S. Like *Abecedarian*, or the *Abcdarium Naturæ* of Lord Bacon, *Elementa* has been said to be composed of L, M, N, the letters whose sounds seem to be heard in the word. The cabinet of Charles II. (1670) was, in no amiable mood, branded as the *Cabal*, from the initials of its five members, Clifford, Ashley, Buckingham, Arlington, and Lauderdale. *Cabaler*, in French, signifying *to intrigue*, existed long before, and doubtless suggested the *mot*. This party-term of 1670 has rendered the Hebrew word for occult science familiar to English ears. The absurd expression "Teetotalism," is, I think, connected with the well known little toy, in which the letter T denoted *totum*, and signified "Take-all." By a process the reverse of that indicated above, the abbreviation IHΣ, has been, in an age unfamiliar with Greek, resolved into initials, and interpreted accordingly.

Abbreviated, however, though many of our words are, the English language abhors outward signs of curtailment. We repudiate to the greatest possible extent the apostrophe and the circumflex. We like to have our lines look staid and unbroken. In this respect a page of English resembles a page of Latin. There is a solid, sensible air about them both. A page of French or of Greek will exhibit a succession of elisions duly notified, and the words generally, besides, appear to be in a state of flurry and effervescence with accents and other little diacritical touches—

> "As thick and numberless
> As the gay motes that people the sunbeam."

We dot our i's and cross our t's, simply to distinguish them from similar parts of other letters. This is the only weakness in which we indulge. We dismiss even from poetry elisions and contractions which Shakspeare and Dryden considered not at all ungraceful. We tolerate "t'other" for "the other," "on't" for "on it," "'em" for "them," only in Humorous Verse. How compact and unfrivolous the pages of Tennyson look! Even the unpronounced *-ed* is left to be discovered by the ear of the reader. Notes of exclamation are suppressed.

"Doeth" has become "doth;" "do on," "don;" "do off,"

"doff;" "do out," "dout;" "d' huit," "doit;" and "natheless" gives no sign of its being "ne'er the less." "Sevennight" is now "sennight;" "moneth," "month;" "sithence," "since." "Prithee" and "good bye" we write as we utter, although the first, of course, is "I pray thee;" and the latter, "Deus vobiscum," "God be with you."

Proper names which, as being foreign in their origin, exhibited a few years since, an apostrophe, are now printed without it; and the capital which followed it is reduced to the ranks. Were it the pleasure of Mr. Disraeli to take one more liberty with his patronymic, and terminate it with a *y* instead of an *i*, the next generation would scarcely notice in it any trace of Hebrew origin.

On observing a review lately of the Life of a certain Capodistrias, I by no means recognized in a moment an old acquaintaince, Capo-d' Istrias, whose name was familiar in mens' mouths at the time of the Greek Revolution.

In like manner, Dorsay, Darcy, Doily, Dacier, are now common forms. This Anglicising process in regard to proper names of foreign origin, is, however, nothing new. Dalton, Dexter, Denroche, Dangerfield, and many another family appellation in D, were once written with an apostrophe. Dexter and Dangerfield suffer two violations; the one being properly D'Exter, *i.e.*, of Exeter, and the other D'Aungerville, not involving "field" at all. *Diaper* from *d'Iprès*, and *Dindon* from *d'Inde* are examples well known.

In another set of names which originally began with a vowel, a disguise is produced by the elision of the article; as in Langley, Larcher, &c. In others, again, it is the Anglicised sound only that causes us to forget that they are properly French, as Mallet, Calmet.

In this connexion it may be added that although the pronunciation *Pree-do* may be cultivated in some families, plain Cornishmen, among whom the name is common, persist in making it *Pri-deaux*, with an *x*, just as the rest of England will say *Vaux* and *Jacques*. And so I remember at Cambridge, Professor Prime's name continued as it was, notwithstanding an effort at one time to improve it into de la Prime. So to recal Seymour and Sinclair to Saint Maur and St. Clair is as bootless an undertaking as it would be to resolve back into Hugh de Bras, the immortal Hudibras.

(*To be continued.*)

ON CERTAIN MODERN VIEWS CONCERNING THE ORDINAL ARRANGEMENT OF THE HIGHER MAMMALIA.

BY DAVID TUCKER, M.B., B.A., T.C.D., ETC.

All who have devoted any attention to the science of Zoology must be aware that the two best known systems of classification are those of Linnæus and of Cuvier. They must also be aware that there are some points on which the two systems are at variance. This, of course, was to be expected, as Cuvier had the advantage of travelling for a considerable distance on a track which Linnæus had vastly improved, if not almost entirely created. We have also to bear in mind that, labouring in an epoch in which civilization had become somewhat more advanced—a season of greater intellectual and commercial activity—the opportunities which Cuvier enjoyed of increasing his stock of knowledge, and of verifying his doctrines by the examination of actual specimens, were much more ample than those which fell to the lot of Linnæus.

Linnæus appears to have arranged the Mammalia chiefly with a regard to their dentition, whilst Cuvier, to a certain extent, revived the plan of Aristotle, which had a view to general anatomical distinctions. In the ordinal arrangement of the higher Mammalia there is also a considerable difference between the two systems. The characteristics which Linnæus ascribes to the first order of this class, are—"Front teeth incisors; the superior, four; parallel. Two pectoral mammae." In consequence of the frequent concurrence of these characteristic marks in individuals in the animal kingdom, this order, which he has named *Primates*, extended itself to very large dimensions. It commenced so low as animals of a rodent or insectivore type, and ascended as high as Man himself. The bat, the lemur, the monkey, the anthropoid ape and the Caucasian man were thus grouped together in rather ludicrous proximity. After a time this arrangement ceased to give satisfaction to the scientific world. Naturalists who had devoted some attention to the study of comparative anatomy, amongst whom was John Hunter, perceived that the principles were not correct, which led to this close approximation of all those apparently diverse genera. And when Baron Cuvier, in his justly celebrated "Regne Animal" introduced a new and more scientific system of arrangement, that of

Linnæus, though a wonderful accumulation of knowledge, and a monument of industry, was to a certain extent superseded.

In Cuvier's arrangement, the animals which composed the first order of Linnæus, are scattered throughout three or four other orders. Out of the monkey tribe, apes, and man, he has established two distinct orders. The first order is that of the Bimana: the second, that of the Quadrumana. In the first order there is only one Genus, Homo; in the second there are several Genera.

There can be no doubt that the doctrines which Linnæus propounded were not in all cases established upon firm and incontrovertible data. As regards the character of the anthropomorphous animals he appears to have been particularly ill-informed. From his description of these creatures one would imagine that he had imbibed and given credence to the vague and unscientific notions of the vulgar; and that he had never attempted to find a strict line of distinction between the man and the ape. Modern naturalists are of opinion that, of his own observation, he knew nothing concerning the anthropoid apes of either Asia or Africa. He had a pupil named Hoppius, who published a dissertation, accompanied by a wood-cut, on these animals, in the "Amœnitates Academicæ," and we may reasonably conclude that he had derived his opinions on this subject from his great master. The wood-cut represents four figures, the originals of which never existed, except in the imagination of the delineator. The first of these he styles "Troglodyta Bontii." It represents really a human female with a covering of hair. Bontius had described it as an Ourang Outang, and Linnæus introduces it into his "Systema" as "Homo Nocturnus." The second is styled "Lucifer Aldrovandi." Hoppius is of opinion that it belongs to a cat-tailed and cannibal race of people. Linnæus names it "Homo Caudatus," and ranks it as a third species of man. The third figure is styled "Satyrus Tulpii," and approaches more nearly than the others to the appearance of an ape, save in the head, face and feet, which too closely resemble the corresponding parts of man. The fourth is called "Pygmæus Edwardi." The proportions of its limbs are not at all those which characterise the limbs of an ape, and the face is much too human in its aspect. Buffon enjoyed opportunities of examining live specimens of anthropoid animals which Linnæus did not, and his observations did good service in dispelling the clouds of superstitious ignorance which enshrouded the whole subject. So little was known of the natural history of man in the time

of Linnæus, that even that illustrious philosopher, in his Systema Naturæ, has found a separate place for children lost in the woods, and growing up in speechless solitude. These he classes under the title of *Homo sapiens ferus,* and appends the complimentary characteristics of "*tetrapus, mutus, hirsutus ;*" thus coinciding to a certain extent with the views of Rousseau, who came to the conclusion that probably many animals of an anthropoid character, which travellers had pronounced to be beasts, were really genuine wild men (*véritables hommes sauvages*), in the primitive state of nature.

The arrangement of Cuvier, that, namely, of placing man in a distinct order by himself, the order comprising only one genus and one species—thus at once establishing his preëminence, and asserting the unity of the human family, appeared to satisfy the most enlightened philosophers of his time. Eminent physiologists supported his doctrine, the great name of Blumenbach being ranged on his side. Indeed Blumenbach has the credit of being the originator of the arrangement of Cuvier. It certainly was gratifying to human beings that Homo, if he must consent to be styled an animal, should stand alone in order, genus and species, the head and monarch of the animal creation. But he has not been allowed to enjoy his dignified solitude without murmurs of dissatisfaction. The close approximation to him in structural characteristics observed in other mammalia, and particularly in the Quadrumana, has led some naturalists to the conclusion that he cannot justly occupy a whole order in the animal kingdom. The hypothesis of development, which has of late years excited much interest in the scientific world, has imparted a stimulus to enquiry on this subject; and we find, as we should naturally expect, that those who regard that theory with favor, are the persons who are most ready to dispute the arrangement of Cuvier.

The object of the present paper is to bring before the members of the Institute, whose studies have not lain in this direction, a brief *resumé* of the arguments adduced to prove that man possesses no right to monopolize an entire, distinct, and preëminent order.

The most concise mode of fairly representing these arguments will be to analyse an essay on "The Relations of Man to the Lower Animals," contained in a work entitled "Evidence as to Man's place in Nature," not long since published by Professor Huxley of London, a gentleman who, however we may differ from him on disputed points, is deserving of our respect and attention. His claim to these is founded

on his high attainments, his incessant labours in the field of science, and his apparent desire to arrive at truth. He has embraced, though not fully and unreservedly, the development hypothesis of Darwin. His own admissions on the subject are, "I, for one, am fully convinced that, if not precisely true, that hypothesis is as near an approximation to the truth, as, for example, the Copernican hypothesis was to the true theory of the planetary motions." (p. 127). Again, he says, "I adopt Mr. Darwin's hypothesis, therefore, subject to the production of proof, that physiological species may be produced by selective breeding." (page 128).

Prof. Huxley with very little ceremony throws aside the arrangement of Cuvier, respecting the ordinal position of man. To a certain extent he reverts to the arrangement of Linnaeus, retaining the old Linnaean term for the order in which he places man, namely *Primates*. In this order he finds seven distinct families. These are

Anthropini,	comprehending	Man alone.
Catarhini,	"	the old world Apes.
Platyrhini	"	the new world Apes, except the Marmosets.
Arctopithecini	"	the Marmosets.
Lemurini	"	the Lemurs.
Cheiromyini	"	Cheiromys, of a Rodent type, and
Galeopithecini	"	Galeopithecus, a flying Lemur resembling a bat.

The grand point which it is his aim to establish, and by using which, as an argument, he desires to justify this arrangement, is "that the structural differences which separate Man from the Gorilla and the Chimpanzee are not so great as those which separate the Gorilla from the lower Apes." And in order to make this point clear and credible, he descends to particulars, commencing as low as intra-uterine existence. The following is an abstract of his argument. All animals, save the very lowest, are produced from an ovum. The ovum of a chicken and that of a dog are primarily identical in character. Man himself originates in a similar germ. It is some time before Man, in his embryo state, can be distinguished from the young puppy, but in the course of development, the human embryo comes to differ from that of the dog, in characteristics. The placenta, for example, of the dog assumes a zone-like form, whilst that of Man becomes dis-

coid or cake-like. Strange to say, the same form of placenta is to be found in the Apes as in Man. Man is, therefore, identical with the animals immediately below him in the earliest stages of his formation, as well as in the physical causes by which he originates. The mode of nutrition, both before and after birth, is the same for Man and these animals. Man is, in substance and in structure, one with the brutes.

As regards physical characteristics after birth, by relative admeasurement of the limbs of Apes, we find that in whatever proportion of its limbs the Gorilla differs from Man the other Apes differ more widely from the Gorilla; and consequently such differences of proportion can have no ordinal value. In the Gorilla the total number of vertebrae, taken together, equals the number of the vertebrae of Man, although the numbers of each kind do not agree in both animals. In Man the normal arrangement is 7 cervical, 12 dorsal, 5 lumbar, and 5 sacral (consolidated), to which may be added 4 small bones which join to form the coccyx. The Gorilla has, normally, 13 dorsal vertebrae and corresponding ribs, whilst Man has only 12. But Man has occasionally 13 pairs of ribs, and the Gorilla occasionally 14. Yet the lower *Primates* differ more from the Gorilla in this particular than the Gorilla does from Man. As, for example, the Douroucouli has normally 14 dorsal and 8 lumbar vertebrae, and a Lemur, (Stenops tardigradus), has 15 dorsal and 9 lumbar. The Gorilla and Chimpanzee when young have curves in the vertebral column, to a certain extent resembling those to be observed in Man, whilst in young Ourangs the column is either straight, or the concavity is anterior, instead of posterior. In the Pelvis the distinctions are equally marked. That of the Gibbon has quite a quadrupedal character, and differs much more from that of the Gorilla, than the Pelvis of the Gorilla differs from that of Man. Again, in the matter of the Cranium; the lowest human skull has a capacity nearly double that of the highest Gorilla. Yet the difference in the capacity of the crania of the different races of men is greater, absolutely, than that between the lowest Man and the highest Ape, whilst relatively, it is about the same. Thus the maximum human skull contains 114 cubic inches.

The minimum - - -	62	"
The difference being - - -	52	"

Next compare the minimum human skull, -	62	cubic inches.
With the maximum skull of the Gorilla,	34.5	"
And the difference is only - - -	27.5	"

Secondly, the adult crania of Gorillas differ among themselves nearly one-third. Thus, the maximum that has been measured

contains - - - -	34.5	cubic inches,
And the minimum only - -	24.	"
The difference being - - -	10.5	

Thirdly, after making due allowance for difference of size, the cranial capacities of some of the lower Apes fall nearly as much, relatively, below those of the higher Apes, as the latter fall below Man. The conclusion from this is, that as regards cranial capacity, men differ more widely from one another than they do from the Apes, whilst the lowest Apes differ as much from the highest as the latter does from Man. In other parts of the skull corresponding differences (relatively) are to be found. For example, the Gorilla has large superciliary ridges, corresponding to internal sinuses, which the Ourang does not possess at all. The occipital foramen in the Lemurs is situated completely in the posterior aspect of the skull, or as much further back than that of the Gorilla, as that of the Gorilla is further back than that of Man; whilst the Platyrhini contains one member, the Chrysothrix, whose occipital foramen is situated further forward than any other of the *Primates* except Man. In dentition and in the viscera, the differences are as great between the Gorilla and the lower members of his order, as between Man and the Gorilla. Man has been defined as the only animal possessing two hands terminating his fore-limbs, and two feet terminating his hind-limbs; but the termination of the fore-limb of the Ape is a true hand, and that of the hind-limb a true foot, with a very moveable great-toe. It differs from the foot of Man in mere proportions—in the degreee of mobility—and in the secondary arrangement of its parts. Every Ape, Monkey, and Lemur possesses a flexor brevis muscle, an extensor brevis, and a peronæus longus in the hind extremity. These muscles are never found in a hand. The thumb and great toe of the Ourang differ more from those of the Gorilla than those of the Gorilla do from the corresponding organs of Man. As regards the Brain, there is a great difference

in the different members of the order *Primates*, but the greatest hiatus does not lie between Man and the anthropoid Apes, but between the Apes and Monkeys and the Lemurs. The Lemur has its cerebellum partially visible from above, and the posterior lobe, with the contained posterior cornu and hippocampus minor rudimentary. All the other members of the order have the cerebellum entirely hidden by the cerebral lobes, and possess a posterior cornu and hippocampus minor well developed. Although the volume of the brain is much greater, proportionally and absolutely, in Man than in the Apes —the brain of the heaviest Gorilla weighing 20 ounces, whilst the largest human brain weighs 65 ounces, and the smallest adult human brain weighs 31 to 32 ounces—yet we must not lay too much stress on these facts, as intellectual power does not depend altogether on the brain. That organ is only one condition on which "intellectual manifestations" depend. The cerebral differences between Man and the Apes are not of more than generic value, his family distinction resting chiefly on his dentition, pelvis and lower limbs.

The conclusion, then, formed from all these particulars is, that Man differs in structure no more from the higher Apes, than the higher Apes differ from the lower *Primates*—that this Order leads us "insensibly from the crown and summit of the animal creation, down to creatures from which there is but a step, as it seems, to the lowest, smallest, and least intelligent of the placental Mammalia."

Pursuing the argument, Prof. Huxley continues—"If man be separated by no greater structural barrier from the brutes than they are from one another, then it seems to follow that if any process of physical causation can be discovered by which the genera and families of ordinary animals have been produced, that process of causation is amply sufficient to account for the origin of Man. In other words, if it could be shown that the Marmosets, for example, have arisen by gradual modification of the ordinary Platyrhini, or that both Marmosets and Platyrhini are modified ramifications of a primitive stock, then there would be no rational ground for doubting that Man might have originated, in the one case, by the gradual modification of a Man-like Ape; or in the other case, as a ramification of the same primitive stock as those Apes."

On first reading Prof. Huxley's views on this important subject, it is really difficult to discover how far he intends his preliminary argument to carry him. It will be observed that the conclusion just

quoted is an hypothetical one. It all depends upon an "if." The plain and bare argument, so far carried, appears to be something like the following:—"I regard man as an animal only. The anatomical differences between him and the higher Apes are not greater than between these and certain other animals, some of a rodent, and some of an insectivore character, which I include in the same Order: *ergo*, the Apes, Monkeys, and Lemurs, must be placed in the same Order as man; and *if* Mr. Darwin's hypothesis of development be correct, there is no rational ground for doubting that Man was, originally, an Anthropoid Ape." This is the real argument as far as I can extract it, after patient examination. But strange to say, in his subsequent remarks, Prof. Huxley seems to throw aside that important "if," and speaks of mankind as though our origin was unquestionably identical with that of the brutes. He asks, for example, (p. 30), "Could not a sensible child confute by obvious arguments the shallow rhetoricians who would force this conclusion upon us?" And what is the conclusion to which he refers? "That the belief in the unity of the origin of Man and the brutes involves the brutalization and degradation of the former." Again, he says (p. 131), "Thoughtful men once escaped from the blinding influences of traditional prejudices, will find in the lowly stock whence Man has sprung, the best evidence of the splendour of his capacities, and will discern in his long progress through the Past, a reasonable ground of faith in the attainment of a noble Future." And in the concluding paragraph of his essay, he goes so far as to state of Man that upon it, (namely, an accumulated experience), he stands as upon a mountain-top, far above the level of his humble fellows.

From such language as this it is impossible to avoid the conclusion that the writer of it would willingly accept all the consequences of the development hypothesis as regards our race, if the difficulties connected with it, and which he appears to consider by no means formidable, were taken out of the way.

But, to proceed with the tangible portions of Prof. Huxley's argument, supposing that he had established his preliminary position that Man differs less in *structure* from the higher Apes than these differ from the lower ones, does it necessarily follow that Man must be arranged in the same Order with these, and they styled his "fellows?" The question resolves itself into this,—Are we to classify all animals merely according to their anatomical phenomena, with no

regard to aspect, habits, powers, capacities, and structural or typical perfection? Are we to ignore the fact, pressed upon our attention from within and from without, in a thousand different ways, that Man is a compound being, compound in a sense in which no other animal is so?

Those who have paid any attention to the natural history of Man must be acquainted with the list of distinctive characteristics which are pointed out as forming a barrier between him and all other animals. Lawrence, who has studied the subject closely, gives sixteen of these. But all of these sixteen may not be absolutely necessary for the purpose required. A few of them so signally mark Man's preëminence over the brutes, as to be sufficient to establish him in his true position as Archon of the whole animal kingdom.

Modern naturalists who are not prepossessed with the hypothesis of development, lay much stress on Man's pre-eminence in the matter of that wonderful organ, his Hand, which vindicates his claim to be ranked by himself in the order of *Animalia Bimana*. The term which they apply to the hands of Man, in contradistinction to those of the Quadrumana, (which name, by the way, Prof. Huxley attempts altogether to explode), is *Cephalic*. That is, they belong to the head, they are used by cerebral guidance, and are not, in the adult, organs of progression, whilst the corresponding organs of the Quadrumana always are. Although the fore-limb of the Quadrumana is furnished with a hand, yet it is a much less useful and capable organ than that which Man possesses. The thumb of the Quadrumana is short and weak, in the Ourang and Chimpanzee reaching no further than the metacarpo-digital articulation. The human thumb is so powerful and useful, acting in opposition to the fingers, that Albinus has described it as a smaller hand aiding the larger one—"*manus parva, adjutrix majori*."

Secondly, Man's smoothness of integument, particularly marked in the female, distinguishes him from the quadrumanous animals. The absence of all means of defence and of covering, supplied by nature, shows that he must rely on his superior mental qualifications, as an inventor and mechanician, for a supply of these.

Thirdly, Man possesses a capability of adapting himself to external circumstances, atmospheric, climatic, and dietetic, which no other animal can lay claim to. The Quadrumana are all natives of warm climates, and when removed to a certain distance from the equator,

usually pine away and become diseased. Man is found in all latitudes from above 70° to the equator. He can thrive and propagate in all these latitudes, and bears a change from intense heat to intense cold often with apparent impunity. He can subsist on a vegetable diet, or on one almost exclusively animal.

Fourthly, The conformation of the human body amply proves that the erect attitude is natural to Man. The absence of facial projection, the mode in which the head is articulated with the spine, the length of the lower limbs when compared with the upper, the depth and thickness of the superior lip of the acetabulum, and the painful efforts necessary, when on all-fours, to fix the eyes on an object directly in front, are sufficient to establish this fact, which is still further confirmed by the uniform erect progression of all savages, even when first discovered by civilized men. Among the ancients the erect position was regarded as a very important mark of Man's superiority to the lower animals; and their poets have some finely expressed ideas on the subject.

It is true that some of the Anthropoid Apes occasionally attempt a sort of erect attitude in progression, but their efforts to maintain it are exceedingly awkward. The Gibbon has to hold the upper extremities over the head to balance itself, or fix them occasionally on the ground to render its gait steadier. The Gorilla is said to raise itself to the erect attitude when about to make an attack; but the Ourang is incapable of the erect posture. Linnæus could not have been well informed on this subject when he wrote of the Simiæ—"*erecto corpore binis æque ac homo pedibus incedentes.*" There is no ground for such an assertion. When Apes attempt to walk erect they tread on the outside edge of their feet, rocking and wavering from side to side. The gait of the Gibbon is a succession of hops; and the natural mode of progression adopted by the Gorilla is a shuffling or swinging gait, the fore-limbs being used much in the same way as crutches are used by a lame person. When he attempts the erect position his hands are employed in balancing his body. On the other hand, the feet of Man are firm, broad, solid and strong. The crural, femoral, and pelvic muscles, are sufficiently powerful to keep him in the erect position, leaving his hands at liberty to carry out the commands of his head. Man is the only animal known which has a foot with toe and heel that plant themselves firmly and at the same time upon the earth. None of the Apes, Monkeys, or Lemurs,

can support themselves, in equilibrio on one foot, as Man easily does. The Quadrumana are all hylobatic animals. All their limbs are prehensile, and, as such, are used as organs of progression. It is true that the extremities of the fore-limbs are employed as hands for conveying food to the mouth, but the same may be stated of several other animals, such as the squirrel, the rat, and the racoon, which, for lack of a thumb, are obliged to make the one fore-paw oppose the other. The length of the digits and the existence of a thumb enable the Quadrumana to grasp tolerably large articles in one extremity.

Fifthly, Man possesses an acquired voice, or power of articulation for the conveyance and record of ideas. The lower animals, in common with Man, have a natural voice, but where an attempt has been made to teach an acquired voice to any of these, although the physical organs might respond to the effort, yet the want of mental power, to form a continuous succession of ideas, has always limited their speech to a very few words or phrases, which they repeat without any conception of their meaning. They are quite incapable of acquiring language, properly so called. This distinction between Man and the other animals, being so striking, has been insisted on from a very early period. Readers of Homer will remember how very frequently he applies the adjective *μέροψ* to human beings, and to these alone. Indeed the word is sometimes used in the plural as a noun, signifying "men."

The last distinctive characteristic which I think necessary to allude to is the superior mental powers and capabilities of Man. These it would, of course, be idle to dwell upon. Although Prof. Huxley tells us that "even the highest faculties of feeling and of intellect begin to germinate in the lower forms of life," and asks with apparent indignation, "Is mother-love vile, because a hen shows it, or fidelity base, because dogs possess it?"—yet the power and capability of Man's intellect are utterly unapproachable by the lower animals. Leaving out of view Man's capacity for civilization—his delight in beauty, truth, and goodness—his ability to interpret the laws of Nature—and his aspirations after immortality—does not that being rightfully claim to be segregated from all fellowship with brutes, who can turn his thoughts inwards and investigate the mysteries of those laws which regulate the actions of the mind itself, as if the objects of his inquiry were solid and tangible substances lying in the hollow of his hand; and who can, above all, not only reason reverentially concerning the character and

essence of the Animating Spirit of the universe, but hold an invisible communion with that beneficent Parent?

It is upon these six characteristics that Man may base his right to repudiate all fellowship with the lower animals, save in the fact of his enjoying an animal existence and submitting to the laws which govern the animal kingdom. Many other distinctive marks can be adduced, but can hardly be considered necessary, if full value be accorded to the six above enumerated. Those, however, which depend upon Man's superior cerebral organization, and which have been so ably demonstrated by Owen, are well worthy of examination.

However ingeniously Prof. Huxley has reasoned upon the fellowship of Man with the brutes, there are many who will not appreciate his argument as highly as he does himself. They will naturally reason on this wise. If Nature chooses to bring Man into existence through the medium of an ovum, in the same way as she introduces to the world a dog or a chicken, and if, before and after birth, man is nourished as other placental mammals are, this only proves the consistency and uniformity of Nature in her laws. If man be in his corporeal part an animal, why should Nature, in his case, depart from the law of animal reproduction and nutrition? That, up to a certain point of embryonic life he cannot be distinguished from a dog, is not to be regarded as a proof of the characteristic and essential identity of the two up to that point, but of our inability to penetrate deeply enough into the mysteries of Nature to perceive a distinction. As to Prof. Huxley's position, that Man is one in substance and in structure with the brutes, it may be replied—If Man was created a denizen of the same planet as these animals, with organs of animal life suited to his position, should we not expect his substance to be similar to theirs? If he had to breathe an atmosphere and feed on organic substances of the same chemical composition, his bone and his muscle and his blood would, in accordance with natural laws, present characteristics similar to those of other animals. And so of anatomical structures. In this particular we might justly expect a similarity corresponding with the similarity of position in which both, as living beings are placed. The laws of pneumatics are obeyed in respiration, of hydraulics in circulation, of optics in vision, of mechanics in muscular action. If these laws are suitable to Man as an animal, why may they not regulate the economy of the brute, and his structure also be arranged for the action of these laws? It appears unworthy of a philosopher when reasoning

of such a being as Man to identify him in origin with the brutes, because the bony and muscular system may, to a certain extent, correspond in both. If man was destined to inhabit this earth in the character of an animal, how could we expect that he should be utterly diverse from every other living being on its surface?

Now upon the subject of cranial capacity, if there are 52 cubic inches of difference between that of the largest and the smallest human skull (probably that of an idiot), which can be found, and only 27½ between this smallest human and the largest quadrumanal—the weight of whose body may have been double that of the owner of the small human one—what a proof this is of the vast superiority, proportionally, of the capacity of human crania! Let us change the arrangement provided for us and compare the highest human, 114 cubic inches, with the highest quadrumanal, 34½, and we find the difference to be 79½ cubic inches. This is a great superiority in point of cranial capacity over the brutes. Next let us look at the conformation of the crania themselves. Man's towering over his visage, and presenting a large surface in proportion to his facial development—the Ape's retreating behind, and not properly above his face at all. What if the dentition of the highest Apes differs less from Man than it does from the lower and lowest Apes, when the highest Ape possesses canines which are absolute tusks, and those of the Cynocephalus, or Baboon, rival the tusks of the Boar? As to the hind limb of the Gorilla being terminated, not by a hand, but by a true foot, Prof. Huxley has to acknowledge that, though, as in Man, every Ape, Monkey, and Lemur, possesses a flexor brevis, an extensor brevis, and a peronæus longus, yet in the Gorilla, and much more in the lower Apes, there is a different arrangement in the insertion of the muscles. But if the presence or absence of certain muscles, or the arrangement of certain bones are to decide us in pronouncing on an organ, whether it is a hand or a foot, some regard ought certainly to be paid to function. If, speaking with strict anatomical precision, the termination of the hind extremity of the Gorilla is a foot, yet it is a strong prehensile organ, which the foot of Man is not. It was this prehensile character which caused Tyson to apply the term "Quadrumana" to such creatures, and whatever may be the osteological and muscular arrangement of the foot of the Ourang, it is evident from its conformation and use that it is *de facto* a hand.

Nor is it easy to assent to Prof. Huxley's assertion, that the cere-

bral differences between Man and the Apes are not of more than generic value. The vast and unapproachable development of the hemispheres, and their lofty proportions, would appear to establish a greater difference than this. Even the amount of cerebral substance itself places comparison almost out of the question. Let us, as before, change the formula provided for us, and compare the highest man with the heaviest gorilla. The proportion then, in ounces, is 65 to 20. The surface of the human brain is furnished with many more convolutions, than that of the Chimpanzee, which Prof. Huxley figures, (the opportunity of examining the brain of the Gorilla being rare). And it will be perceived, in examining Prof. Huxley's plate, that if a posterior cornu of the ventricle and a hippocampus minor exist in the brain of this animal, they appear by no means so well defined or developed as in the human brain figured alongside.

The fact of the great gap that exists between the Apes and Monkeys and the Lemurs, in this, that the cerebellum in the Lemur is partially visible from above, would rather lead some naturalists to conclude that the Lemur had less business than ever, this being known, to intrude itself into the Order in which Homo occupies a place. But in reference to the actual preponderance of brain, Prof. Huxley places less value on this as a characteristic of Man, than most other writers on the subject. He states that "the brain is only one condition out of many, on which intellectual manifestations depend; the others being chiefly the organs of the senses and the motor apparatases, especially those that are concerned in prehension, and in the production of articulate speech." Now this doctrine certainly sounds strangely to those of us who have been taught in the old-fashioned system of physiology, that the brain is the organ of mind, and to those of us who have seen all "intellectual manifestations" suddenly stopped by a blow upon the cranium. It certainly sounds strangely to myself, who have seen the action of the "motor apparatuses"—as Prof. Huxley styles them—as well as the sensitive ones—the sense of the organ of touch and the powers of motion including that of articulation—simultaneously and permanently arrested by dislocation of the cervical vertebrae, and consequent pressure on the spinal cord, whilst there was no reason to suppose that intellectual power was wanting in the brain during the days in which the wretched sufferer survived. Such a case, surely, demonstrates the paramount importance of the brain, and the utter inefficiency of the motor and sensitive nervous systems as intellectual

manifestors, when their connection with that organ is interrupted. If "intellectual manifestations" ever depend on them it must be in a mediatory sense, their own efficiency depending on that of the brain, and their connection with that great centre of power and intelligence. The doctrine sounds strangely also to those who have learned from the principles of a long established philosophy that the brain is the seat of the mental faculties, and that the organs of the senses are but avenues which lead up to "the dome of thought."

But it is Man's endowment with articulate speech which Prof. Huxley regards as the preëminent advantage which he enjoys over those whom he designates "his humble fellows." "Our reverence" says he "for the nobility of manhood will not be lessened by the knowledge that he is one in substance and structure with the brutes, *for* he alone possesses the marvellous endowment of intellectual and rational speech, whereby in the secular period of his existence he has slowly accumulated and organized the experience which is almost wholly lost with the cessation of every individual life in other animals." Is not this, if the expression be allowed, an argument of a somewhat *hysteron proteron* nature? Which is necessary first, the mind to frame rational speech, that is, language, or the speech to form the mind? Is it by the mind or on the tongue that experience is organized—if by that term is meant its arrangement for future use? And let us ask, what would be the value of mere animal experience without mental capacity to profit by it? Does the bird construct her nest less accurately for her primal incubation than she does for her seventh? Does the beaver or the bee improve by experience in the science of architecture? Is the spider less expert in deceiving and destroying the unwary insect in the month of May than in the month of June? And do we not find that even when articulate speech is denied, intelligent beings can profit by the results of their experience? Do not mutes, whose mental organization is unimpaired, when left in the society of each other, devise certain modes of communicating ideas and recording experience though the organs of speech, as such, be abnormal and useless? The doctrine of Prof. Max Müller, that language is "the outward expression of an inward power," is much more philosophical than the theory we are now glancing at.

In a highly poetic strain Prof. H. draws an analogy between Man and the Alpine mountains, which, he says, though of one substance with the dullest clay, have been raised "by inward forces to that place

of proud, and seemingly inaccessible glory" which they occupy. We naturally ask—what does he imply by drawing such an analogy? Regarding the general tone and apparent aim of his essay, we can form no other deduction from this simile, or analogy, or poetic sentiment, than that Men, modified from Brutes, through the aid of inward forces have raised themselves to their present preëminence. Such "inward forces" as existing in the anthropoid Quadrumana are contrary to experience, within the records of man, and until some proof be adduced of their ever having existed, we should richly merit the application of Prof. Huxley's own neat expression,—"shallow rhetoricians"—if we advocated a theory so chimerical.

To return to the question of Man's proper place in the animal kingdom, on this subject we find a great diversity of opinion amongst naturalists. Swainson, who carried out the Macleay system of classification, has gone to the very opposite extreme from Prof. Huxley, and altogether denied him a place in that kingdom. He could not locate him in any of the various circles into which he had arranged living creatures. There was no circle into which he could thrust him where he could have affinities on each side of him. He therefore concluded to thrust him out altogether, and regard him as a sort of demigod. But the author of the "Vestiges," with his "development" instincts fully alive, though approving of Swainson's arrangement in other respects, condemns this one. He proposes that the typical order of mammalia should be designated Cheirotheria, the possession of hands being their most prominent characteristic. In this order he included Man, not very happily, considering the etymology of the term, which would represent him as a wild and predatory beast.

Regarding man as a compound animal, it is probable that Cuvier's arrangement will be found to afford the most general satisfaction. The six leading marks of distinction between him and the other mammalia appear of sufficient value to entitle him to a solitary place in the highest order of animals—leaving out of consideration that position which has been assigned to him by Revelation and confirmed by human experience—the position of Lord and Governor and Subduer of all other animals, however powerful and however fierce. Nor ought we to consent to regard Apes and Monkeys as members of the highest Order of living creatures till we find some well authenticated instance of any such animal possessing sufficient mental power to make at least an attempt at intelligible language—or manifesting some sense,

however vague, of a future life—or acknowledging by adoration, or in some other intelligible mode, the existence of a supreme and spiritual Being.

NOTE ON THE PRESENCE OF PHOSPHORUS IN IRON WIRE.

BY E. J. CHAPMAN, Ph.D.

PROFESSOR OF MINERALOGY AND GEOLOGY IN UNIVERSITY COLLEGE, TORONTO.

(Read before the Canadian Institute, March 12, 1864.*)*

UPWARDS of twenty years ago, thin iron wire was stated by Griffin, in his "Chemical Recreations," (Ed. 8, p. 154), to exhibit, in burning, a green light. This statement is repeated by Prof. Galloway in the various editions of his useful little work on chemical analysis: iron wire being placed in one of the tables, given in that manual, amongst the substances which impart a green coloration to the blowpipe-flame. In this connexion, it is curious that neither Berzelius, Plattner (*Löthrohrprobirkunst:* 1834, 46, 53), Dr. Harald Lenz (*Die Löthrohrschule:* 1848), Scheerer (*Löthrohrbuche,* 1849, 57), Bruno Kerl (*Leitfaden bei qual. und quan. Löthrohr-Untersuchungen,* 1859, 62), nor any other of the numerous workers with the blowpipe on the continent of Europe, have ever alluded to this reaction. Lenz gives a minute account of the action of the blowpipe-flame on iron wire, and points out that the fusion of the wire is always accompanied by oxidation; but he makes no allusion to any coloration of the flame.

Struck by this apparent omission, I have lately examined a great number of iron wires by the blowpipe. I find that all the light-coloured and comparatively hard wires exhibit the reaction very distinctly—a bright green flame streaming from the point of the wire during the oxidation and fusion of the latter, whilst a rapid scintillation, or emission of sparks, accompanies the phenomenon.

On the other hand, the soft and dark wires fuse much less readily, and do not occasion the slightest coloration of the flame.

On investigating the subject more fully, I have discovered that the green coloration, produced by the hard and light-coloured wires, is due to the presence of a minute amount of phosphorus—this being converted into phosphoric acid during the combustion or oxidation of the wire. After the solution of a sufficient quantity of wire in nitro-hydrochloric acid, and the precipitation of the iron by ammonia and sulphide of ammonium, the phosphoric acid may be thrown down, by a magnesian salt, as phosphate of ammonia and magnesia. This latter compound can then be tested farther by nitrate of silver, molybdate of ammonia, &c.

As iron wire is often employed in blowpipe experiments as a reagent for phosphoric acid, and as it is also occasionally used in the estimation of phosphorus in cast iron (Regnault: *Chimie* iii. 127), the publication of this note may not be without its use.

MEAN METEOROLOGICAL RESULTS AT TORONTO, FOR THE YEAR 1863.

BY G. T. KINSTON, M.A.,
DIRECTOR OF THE MAGNETICAL OBSERVATORY.

THE mean temperature of the year 1863 was 0°.45 in excess of the average annual temperature of twenty-two years. The oscillations of the monthly means, above or below their respective average monthly means, had an average amplitude of 1°.81, which, though slightly greater than the corresponding number (1.°42) for the year 1862, was considerably less than the average amplitude of the monthly oscillations (2°.44) in twenty-two years.

The mean deviations of temperature in the four seasons, with their proper signs, and regarding the winter as including December, 1862, were +2°.22 in winter, —0°11 in spring, +0°.02 in summer, and +0°.28 in autumn. Hence as regards its temperature, the year, though beginning with a mild winter, was regular in the other seasons.

There was a deficiency in the rain and snow, amounting to 3.715 inches of water. A deficiency occurred in the spring, summer, and autumn; but an excess in the winter, commencing December, 1862, as well as an excess in December, 1863. The deviations in the amount of precipitation, with their proper signs, in the four seasons, were +1.187 inches in winter, —0.755 inches in spring, —2.263 inches in summer, and —2.569 inches in autumn.

In the following summary, several of the results for the year 1863 are compared with the averages derived from a series of years, as well as with the extreme values of analogous results that have occurred during the same series.

TEMPERATURE.

	1863.	Average of 22 years.	Extremes.	
Mean temperature of the year ..	44°.57	44°.12	46°.36 (in 1846)	42°.16 (in 1856)
Warmest month..............	July	July	July, 1854	Aug. 1860
Mean temperature of the warmest month	67°.57	66°.85	72°.47	64.46
Coldest month	February	February	Jan. 1857	Feb. 1848
Mean temperature of the coldest month	22°.41	22°.98	12°.75	26°.60
Difference between the warmest and the coldest months	45°.16	43°.87	—	—
Mean of deviations of monthly means from their respective averages of 22 years, signs of deviations being disregarded.	1°.81	2°.44	3°.55 (1843 & 1857)	1°.35 (in 1853)
Months of greatest deviation, without regard to sign	January	January	Jan. 1857	—
Corresponding magnitude of deviation	4°.5	3°.9	10°.7	—
Warmest day	July 1	July 20	July 12, 1845	July 31, 1844
Mean temperature of the warmest day	75°.12	77°.28	82°.32	72°.75
Coldest day	Feb. 4	Jan. 24	Feb. 6, 1855 Jan. 22, 1857	Dec. 22, 1842
Mean temperature of the coldest day	—4°.52	—0°.87	—14°.38	+9°.57
Date of highest temperature ..	Aug. 19	July 22	Aug. 24, 1854	Aug. 19, 1840
Highest temperature........	88°.0	90°.4	99°.2	82°.4
Date of lowest temperature....	Feb. 4	Jan. 25	Jan. 26, 1859	Jan. 2, 1842
Lowest temperature	—19°.8	—12°.2	—26°.5	+1°.9
Range of the year............	107°.8	102°.6	118°.2 (in 1855)	87°.0 (in 1847)

BAROMETER.

	1863.	Average of 18 years.	Extremes.	
Mean pressure of the year	29.6536	29.6133	29.6679 (in 1849)	29.5880 (in 1852)
Month of highest mean pressure....	February	Sept.	June, 1849	Sept. 1860
Highest mean monthly pressure	29.7922	29.6629	29.8030	29.6733
Month of lowest pressure..........	June	June	March, 1859	Nov. 1849
Lowest mean monthly pressure	29.5523	29.5624	29.4215	29.5868
		Average of 9 years.		
Date of highest pressure in the year	Feb. 4 (11 A.M.)	—	Jan. 1855	Dec. 1854
Highest pressure	30.502	30.372	30.552	30.245
Date of lowest pressure in the year	April 2 (6 A.M.)	—	March, 1859	March, 1858
Lowest pressure................	28.704	28.592	28.286	28.849
Range of the year................	1.798	1.780	2.106 (in 1859)	1.429 (in 1860)

RELATIVE HUMIDITY.

	1863.	Average of 20 years.	Extremes.	
Mean humidity of the year	77	78	82 (in 1851)	73 (in 1858)
Month of greatest humidity........	January	January	Jan. 1857	Dec. 1858
Greatest mean monthly humidity...	85	83	89	81
Month of least humidity...........	April	May	Feb. 1843	April, 1849
Least monthly humidity...........	68	72	58	76

EXTENT OF SKY CLOUDED.

	1863.	Average of 10 years.	Extremes.	
Mean cloudiness of the year ...	0.61	0.60	0.63 (in 1862)	0.57 (in 1853 & '56)
Most cloudy month	January	Dec.	Dec. 1858 Dec. 1860 Feb'y 1861 Jan. 1863	Dec. 1857
Greatest monthly mean of cloudiness.....................	0.83	0.75	0.83	0.73
Least cloudy month	Sept.	August	July, 1853	June, 1861 May, 1862 Aug. 1862
Lowest monthly mean	0.42	0.45	0.34	0.45

WIND.

	1863.	Result of 14 years.	Extremes.	
Resultant direction	N 41°. W	N 60°. W		
Mean resultant velocity in miles....	1.34	1.82		
Mean velocity, without regard to direction	7.13	6.78	8.55 (in 1860)	5.10 (in 1853)
Month of greatest mean velocity ...	February	March	March, 1860	Jan. 1848
Greatest monthly mean velocity....	10.13	8.60	12.41	5.82
Month of least mean velocity	July	July	Aug. 1852	Sept. 1860
Least monthly mean velocity	3.89	4.91	3.30	5.79
Day of greatest mean velocity	Dec. 14			
Greatest daily mean velocity	21.41			
Day of least mean velocity	July 10			
Least daily mean velocity	0.18			
Hours of greatest absolute velocity	March 31 9.30 to 10.30 P.M.			
Greatest velocity.................	39.0			

RAIN.

	1863.	Average of 21 years.	Extremes.	
Total depth in the year in inches ...	26.483	30.324	43.555 (in 1843)	21.505 (in 1856)
Number of days in which rain fell..	130	106	136 (in 1861)	80 (in 1841)
Month in which the greatest depth of rain fell	Nov.	Sept.	Sept. 1843	Sept. 1848
Greatest depth of rain in one month	3.656	3.973	9.760	3.115
Month in which days of rain were most frequent..................	October	June	June, 1857	May, 1841
Greatest number of rainy days in one month	16	12	21	11
Day in which the greatest amount of rain fell	July 20	—	Oct. 6, 1849	
Greatest amount of rain in one day.	1.665	2.138	3.360	
Hour of heaviest rain	July 20, 6 to 7 P.M.			
Greatest amount of rain in one hour	0.420			

SNOW.

	1863.	Average. 19 & 22 years.	Extremes.	
Total depth in the year in inches ...	62.9	61.6	99.0 (in 1855)	38.4 (in 1851)
Number of days in which snow fell.	74	57	87	33
Month in which the greatest depth of snow fell..........................	February	February	Feb. 1846	Dec. 1851
Greatest depth of snow in one month	22.0	18.0	46.1	10.7
Month in which days of snow were most frequent..................	Jan. Dec. & March	Dec.	Dec. 1859 Jan. 1861	Feb. 1858
Greatest number of days of snow in one month	17	13	23	8
Day in which the greatest depth fell	Feb. 4			
Greatest depth of snow in one day..	16.0			

RAIN AND SNOW COMBINED.

Where ten inches of snow are reckoned as equivalent to one inch of rain.

	1863.	Average of 19 and 22 years.
Total depth in the year in inches of water............	32.773	36.488
Number of days in which rain or snow or both fell	184	160
Month in which the greatest fall of rain or snow occurred	December	September
Greatest amount of rain or snow in one month........	3.670	3.973
Month in which occurred the greatest number of days of rain or snow	January	December
Greatest number of days of rain or snow in one month	22	18

The accompanying table is a general abstract of the Meteorological Observations made at the Magnetic Observatory, Toronto, during the year 1863:

GENERAL METEOROLOGICAL

Provincial Magnetical Observ

LATITUDE, 43° 39′ 4″ North; LONGITUDE, 5h. 17m. 33s. West.—Elevation above

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.
Mean temperature	° 28.08	° 22.41	° 25.84	° 42.03	° 54.30	° 60.13	° 67.57
Difference from average (22 years)	+4.55	— 0.57	— 4.29	+ 1.05	+ 2.91	— 1.23	+ 0.72
Thermic anomaly (Lat. 43° 40′ N.)	—4.72	—12.29	—14.26	— 8.17	— 3.80	— 4.47	— 1.18
Highest temperature	47.0	41.5	42.2	69.0	79.0	84.8	83.5
Lowest temperature	—14.0	—19.8	— 4.0	8.6	36.4	37.4	48.0
Monthly and annual ranges	61.0	61.3	46.2	60.4	42.6	47.4	35.5
Mean maximum temperature	33.32	30.06	32.81	49.99	63.42	69.23	74.88
Mean minimum temperature	22.93	15.47	19.42	33.42	46.26	51.99	59.69
Mean daily range	10.38	14.58	13.39	16.57	17.15	17.24	15.19
Greatest daily range	24.6	35.6	39.6	30.5	34.8	27.2	23.5
Mean height of barometer	29.6466	29.7922	29.6649	29.6453	29.6170	29.5523	29.5963
Difference from average (18 years)	+.0132	+.1800	+.0826	+.0583	+.0324	—.0101	—.0051
Highest barometer	30.378	30.502	30.180	30.078	29.901	29.844	29.912
Lowest barometer	28.846	29.037	29.129	28.704	29.011	28.982	29.390
Monthly and annual ranges	1.532	1.465	1.051	1.374	0.890	0.862	0.522
Mean humidity of the air	.85	.83	.78	.68	.69	.71	.78
Mean elasticity of aqueous vapour	.140	.110	.116	.181	.299	.373	.535
Mean of cloudiness	.83	.66	.63	.54	.48	.54	.64
Difference from average (10 years)	+.12	—.5	+.4	—.4	—.5	+.1	+.19
Resultant direction of the wind	N 61 W	N 23 W	N 27 W	N 14 E	N 56 E	N 50 W	N 18 W
" velocity of the wind	1.13	2.27	2.62	3.75	0.41	2.26	0.40
Mean velocity (miles per hour)	7.23	10.13	9.27	9.20	5.89	5.24	3.89
Difference from average (14 years)	—0.63	+2.05	+0.67	+1.33	—0.73	—0.03	—1.02
Total amount of rain	1.122	1.450	0·687	2.210	3.363	1.662	3.408
Difference from average (21 & 22 yrs)	—0.285	+0.404	—0.861	—0.188	+0.122	—1.438	—0.082
Number of days rain	10	7	4	8	14	13	15
Total amount of snow	20.6	22.0	11.4	1.6	0.1	...	...
Difference from average (19 years)	+ 6.97	+ 3.97	+ 2.26	— 0.91	0.00	...	...
Number of days snow	17	12	17	4	1	...	...
Number of fair days	9	11	13	19	17	17	16
Number of auroras observed	3	4	5	5	0	4	6
Possible to see aurora (No. of nights)	7	14	18	19	18	19	14
Number of thunderstorms	0	0	0	1	3	3	7

REGISTER FOR THE YEAR 1863.

atory, Toronto, Canada West.

Lake Ontario, 108 Feet; approximate Elevation above the Sea, 342 Feet.

Aug.	Sept.	Oct.	Nov.	Dec.	Year 1863.	Year 1862.	Year 1861.	Year 1860.	Year 1859.	Year 1858.	Year 1857.
° 66.58	° 55.88	° 45.95	° 39.13	° 27.00	° 44.57	° 44.35	° 44.22	° 44.32	° 44.19	° 44.74	° 42.73
+ 0.56	− 2.03	+ 0.43	+ 2.44	+ 0.89	+ 0.45	+ 0.23	+ 0.10	+ 0.20	+ 0.07	+ 0.62	− 1.39
− 1.92	− 5.62	− 7.85	− 4.07	− 9.00	− 6.43	− 6.65	− 6.78	− 6.68	− 6.81	− 6.26	− 8.27
88.0	80.0	66.4	67.0	53.4	88.0	95.5	87.8	88.0	88.0	90.2	88.2
42.4	31.4	30.5	17.8	− 1.5	−19.8	− 5.2	−20.8	− 8.5	−26.5	− 7.3	−20.1
45.6	48.6	35.9	49.2	54.9	107.8	100.7	108.6	96.5	114.5	97.5	108.3
75.72	64.49	52.79	44.82	34.00	...	...	...	...	...	...	...
57.98	46.99	40.54	33.34	20.70	...	...	...	...	...	...	...
17.74	17.50	12.25	11.49	13.30	14.73	14.43	14.42	14.24	13.66	13.84	16.38
35.5	27.1	23.8	23.0	28.5	39.6	37.0	33.3	30.7	39.8	31.2	37.0
29.6453	29.7324	29.6972	29.5557	29.6975	29.6536	29.6248	29.6008	29.5923	29.6209	29.6267	29.6054
+.0240	+.0695	+.0472	−.0582	+.0495	+.0403	+.0115	−.0125	−.0210	+.0076	+.0134	−.0079
29.989	30.140	30.218	30.181	30.313	30.502	30.469	30.330	30.267	30.392	30.408	30.361
29.321	29.259	29.272	29.096	28.769	28.704	28.805	28.644	28.838	28.286	28.849	28.452
0.668	0.881	0.946	1.085	1.544	1.798	1.664	1.686	1.429	2.106	1.559	1.909
.76	.75	.80	.80	.83	0.77	0.77	0.78	0.77	0.74	0.73	0.79
.506	.350	.260	.198	.129	.266	.262	.262	.260	.249	.259	.254
.45	.42	.64	.71	.72	0.61	0.63	0.62	0.60	0.61	0.60	0.60
.00	−.08	+.03	−.03	−.03	+.01	+.03	+.02	.00	+.01	.00	.00
S 61 W	N 16 W	S 71 W	N 88 W	N 41 W	N 41 W	N 48 W	N 56 W	N 60 W	N 61 W	N 41 W	N 74 W
1.80	0.92	0.48	3.50	1.61	1.34	2.03	2.11	3.32	2.24	1.59	2.54
4.89	6.46	6.16	7.86	9.40	7.13	7.33	7.47	8.55	8.17	7.64	7.99
−0.28	+1.06	+0.30	+0.37	+1.22	+0.36	+0.56	+0.70	+1.78	+1.40	+0.87	+1.22
2.208	1.235	2.522	3.656	2.960	26.483	25.529	26.995	23.434	33.274	28.051	33.205
−0.743	−2.738	+0.037	+0.516	+1.415	−3.841	−4.795	−3.329	−6.890	+2.950	−2.273	+2.881
12	8	16	13	10	130	118	136	130	127	131	134
...	...	0.0	0.1	7.1	62.9	85.4	74.8	45.6	64.9	45.4	73.8
...	...	− 0.84	− 3.00	− 7.56	+ 1.27	+23.77	+13.17	−16.03	+ 3.27	−16.23	+12.17
...	...	0	6	17	74	72	76	75	87	67	79
19	22	15	12	11	181	189	165	174	169	178	171
5	8	3	1	0	44	48	43	58	53	59	26
19	21	13	10	10	182	176	180	190	199	198	189
8	2	0	0	0	24	24	27	30	30	19	28

FACTS TENDING TO SHOW A DAILY DEVELOPMENT AND TRANSFORMATION OF SEVERAL KILOGRAMMES OF FIBRINE IN THE HUMAN BODY, AND ALSO WHERE THIS DEVELOPMENT AND TRANSFORMATION TAKE PLACE.

BY E. BROWN-SÉQUARD.

(*Translated from the "Journal de la Physiologie de l'homme et des animaux." Tome premier. Paris,* 1858.)

From the researches of Bidder and Schmidt we learn that the quantity of organic matter undergoing transformation in the animal economy, judging of it by the amount of the secretions is very great. The following facts, established by these able physiologists, enable us to form some idea of it: the dog, for example, secretes an amount of gastric juice during the twenty four hours equal in weight to one-tenth of the weight of the animal, nearly twenty grammes of bile are secreted for each kilogramme of the dog's weight in the course of one day. The other secretions, (saliva, pancreatic fluid, succus entericus) are also very large.

We are indebted to Colin of Alfort for numerous experiments confirmatory of the results obtained by Bidder and Schmidt in reference to these various secretions.

The existence of these secretions, and the absorption of a great part of their component elements, imply that extensive modifications are continually taking place in the blood.

The facts about to be submitted lead to the same conclusion.

Lehmann has proved, by experiments made upon horses, and by others, more recently on dogs, that the blood issuing from the liver does not contain fibrine, whilst the blood of the vena portæ contains from 4·24 to 5·92 parts in a thousand in the case of the horse, and from 3·98 to 5·07 in the case of the dog. I have, upon several occasions, satisfied myself that the blood of the supra hepatic veins, in the dog, does not spontaneously coagulate, and yields no fibrine when whipped. Once or twice I have seen a few flocculent fibres in blood from these veins, (not mixed with that from the vena cava.) Lehmann has upon two occasions observed the same thing, but the quantity of fibrine of which these flocculi are composed is too insignificant to be worthy of consideration.

Upon three occasions, I have indeed found a genuine fibrinous clot, in blood coming from the liver, very small it is true ; but the conditions under which this has been noticed render it highly probable that the functions of the liver were at that time partly suppressed. Moreover, after death the blood of the supra hepatic veins is usually found coagulated or coagulable ; due to the admixture of the blood from the liver with that of the vena cava.

Nevertheless it is shown, by the analyses of the eminent chemist of Leipzig, and by my own observation, that during life and in a normal condition, the blood of the supra hepatic veins is devoid of fibrine, or contains only an inappreciable quantity, showing that this element of the blood is transformed in the liver ; or loses, at least, its chief characteristic property.

The same may be said in reference to the fibrine of the blood passing through the kidneys, it almost wholly or entirely disappears ; F. Simon asserts that fibrine is not to be found in the blood of the renal vein. Claude Bernard has also stated that this element is wanting in the blood of the renal vein. I have made researches upon this subject, and have very frequently obtained the negative result recorded by Simon and Bernard. But it is well to know that there exist in this matter, sources of error, which, if not avoided would infallibly lead to the conclusion, that there is as much, or nearly as much, fibrine in the blood of the renal vein as in arterial blood. If, in order to obtain the blood coming from the kidneys, we wound the renal vein, without having previously placed a ligature upon it at its opening into the vena cava, we obtain a mixed blood, a large part of which comes from the vena cava, and must contain fibrine. On the other hand, it sometimes happens, that the urinary secretion is suddenly suppressed when the abdomen is opened. Under these circumstances, the blood returning from the kidneys, has assumed the venous colour, contains fibrine and speedily coagulates. After death in the case of man and other animals the blood of the renal veins is found coagulated or coagulable.

In order to prove that the venous blood from the kidneys does not usually contain fibrine, or only a trace of it, it is necessary, immediately after opening the abdomen to seize with the forceps the two extremities of the renal vein.

By this method, it is true, only a very small quantity of blood is obtained, but it can be satisfactorily shewn that this blood is neither

coagulable spontaneously nor by whipping. If a larger quantity be desirable, one pair of forceps only should be applied at the point of termination of the renal veins in the vena cava, then divide the renal vein, and collect the blood which flows from it. In a few minutes, more than sufficient is obtained than is necessary to prove by the method of whipping, that there is no fibrine in the collected blood. If the blood be allowed to flow for more than three or four minutes, sometimes it may be found to contain a small amount of fibrine, and after seven or eight minutes, this element is almost always present in considerable quantity.

My experiments were made upon dogs and rabbits. It is difficult to succeed, especially with rabbits, on account of the disturbance of the renal function produced by the opening of the abdomen.

The non spontaneous coagulability, the negative results afforded by microscopical examination and by the method of whipping, have satisfied me of the absence of fibrine. Of course I do not mean to say that a substance more or less analogous to fibrine, or resulting from it, does not exist in the blood of the renal vein and of the supra hepatic veins. It is for the chemist to show what transformation fibrine undergoes in the liver and kidneys. What I mean is, that usually, if not always, true fibrine, the element endowed with the property of coagulating, spontaneously, or by whipping, with a free supply of air, and at a moderate temperature, disappears from the blood which traverses the liver and the kidneys. But whether this substance has only lost its chief characteristic property, retaining others, or whether it has suffered complete modification I do not pretend to say, nor for the present to enquire.

If it be so that the metamorphosis of fibrine into one or several substances takes place in the liver and kidneys, it must follow in the case of man, considering the quantity of blood which traverses these organs in the course of twenty-four hours, that probably not less than four or five kilogrammes of fibrine undergo transformation daily. Moreover, as the amount of this constituent does not vary in the normal blood of the general circulation, it must be admitted that there is a daily formation of from four to five kilogrammes of fibrine. This is now to be demonstrated.

Admitting that the left ventricle is completely emptied at each systole, of which, since the researches of Haller, there can be no doubt, from 120 to 180 grammes of blood are expelled at each con-

traction of the heart in the human adult. Now the human heart contracts, in a condition of health, at least from 72 to 78 times in a minute, (according to Guy, Volkmann, &c.,) whence it follows, assuming the lowest figure, 120 grammes and 72 pulsations, in order to be rather under the mean than to take numbers that might be thought too high, that (72 × 120) 8640 grammes of blood are expelled from the left ventricle every minute. In one hour (60 × 8640) 518,400 grammes, and in twenty-four hours (518,400 × 24) 12,441,600 grammes, or in round numbers, 12,440 kilogrammes (1000 kilogrammes are nearly equal to an English ton).

Of these 12,440 kilogrammes of blood leaving the left ventricle in the course of one day, how much passes through the liver and the kidneys? It is impossible to say what this quantity may be exactly, but an approximation may be arrived at sufficiently near the truth for the purposes of our enquiry. According to Ferneley, Paget, Valentin, and Volkmann, the sum of the sectional areas of the branches of an arterial trunk is somewhat greater than the sectional area of the trunk itself.

In reference to the aorta, Paget, adopting the mean of twelve measurements, gives the following proportions:—

The area of a section of the aorta where it emerges from the pericardium, is to the sum of the sectional areas of the three first large branches, and of its thoracic branch, as 1 is to 1.055. Disregarding this slight difference, it may be said from what is known at the present day, that the quantity of blood which flows in a given time, through a large arterial branch, is (nearly) to the quantity of blood which flows through the aorta before it gives off its first branches, as the sectional area of this large branch is to the sectional area of that part of the aorta. Again, the areas of circles being to one another as the squares of their diameters, if the diameter of an artery arising from the aorta, and also the diameter of the aorta before giving off its first branches be known, the quantity of blood flowing through the artery in the course of one day can be readily determined. The diameter of the human aorta at its origin (according to Paget, Valentin, and myself), is about 28 millimetres, the square of which is 784; hence the quantity of blood which flows through the aorta at its origin, and which amounts to, at least, 12,300 kilogrammes, is to the quantity of blood flowing through the

cœliac axis in the same time as 784 : the square of the aortic diameter, is to 25, the square of the diameter of the cœliac axis:—

$$12300 : x :: 784 : 25$$
$$x = \frac{12300 \times 25}{784} = 392 \text{ kilogrammes.}$$

About 392 kilogrammes of blood flow in 24 hours therefore, through the cœliac axis.

A similar calculation gives for the superior mesenteric artery, 384 kilogrammes, and for the inferior mesenteric 343 kilogrammes.

Respecting this latter artery, since a portion of its blood does not traverse the liver, we will subtract 43 from the 343 kilogrammes, and consequently admit that only 300 kilogrammes of blood are supplied to the liver by the inferior mesenteric artery: on adding these quantities of blood which the liver receives daily by the three channels mentioned, we find,—

1. From the cœliac axis....................	392	kilogrammes.
2. From the superior mesenteric	384	"
3. From the inferior mesenteric	300	"
Total	1076	"

Let it be observed that this sum is assuredly not too high, because, in order to arrive at it, very low figures have been assumed (72 pulsations in a minute, and 120 grammes as the amount of blood leaving the left ventricle at each systole).

It may be therefore held that in the adult probably at least 1076 kilogrammes of blood enter the liver daily. Admitting that there are only 2.5 parts in a thousand of fibrine in the blood, from the three arteries which supply the liver, it is evident that this blood loses 2690 grammes of fibrine, in one day, whilst traversing the digestive organs and the liver.

It is difficult to decide whether this amount of fibrine undergoes transformation solely in the liver or partly here and partly elsewhere; but certainly the liver is the chief site of this transformation. Nothing can be learnt with certainty from the analyses of the blood of the vena portæ which shew that it contains relatively less fibrine than arterial blood, and the blood of the superficial veins, because of the changed condition of the blood of the vena portæ, due to the absorption of water, salts, &c.

If instead of allowing 2.5 parts of fibrine, we take 2.3 as being nearer the mean in a normal condition, it will be found that 2475 grammes of fibrine disappear in the course of one day in the blood traversing the digestive organs and the liver; and 2152 grammes if we assume that there are but 2 parts in a thousand of fibrine in the blood. If we make a calculation in reference to the blood supplied to the kidneys, similar to that just made with respect to the blood going to the liver, it will be found that the left kidney receives 457 kilogrammes and the right 481 kilogrammes, whence it follows that the two kidneys receive daily 938 kilogrammes of blood.

Assuming that arterial blood contains 2.5 parts in a thousand of fibrine, there will be a transformation of 2345 grammes of fibrine in the kidneys in one day. If only 2.3 parts of fibrine, the amount would be 2107 grammes; if only 2.2 parts there would be transformed 1876 grammes.

Now, on adding together the amount of fibrine transformed in the liver (and in part also, perhaps, in the other organs of the digestive apparatus), and in the kidneys, we obtain the following results:—

2690 + 2345 = 5035	grms.	of fibrine,	assuming	2.5	parts	in 1000
2475 + 2107 = 4582	"	"	"	2.3	"	"
2152 + 1876 = 4028	"	"	"	2.0	"	"

Whence it follows that an amount of fibrine, varying between four and five kilogrammes at least, undergoes transformation in the course of the circulation of the blood through the digestive and venous viscera every twenty-four hours.

It has been objected by some to whom I have made known these conclusions, that perhaps the fibrine of the blood, instead of suffering transformation, passed in company with the lymph through the liver and kidneys. However puerile this objection may appear, yet since it has been seriously advanced by serious and learned men, I feel bound to reply. According to the researches of Bidder and Schmidt, 10 kilogrammes of lymph flow into the subclavian vein in the course of one day.

Of these 10 kilogrammes, certainly not more than 3 are derived from the liver and the kidneys, however numerous may be the lymphatics of these viscera. In order to give the largest possible support to the objection, let us admit that 5 kilogrammes of lymph are derived from those organs where we suppose the transformation

of the fibrine of the blood to take place. Now admitting that there are 2 parts in a thousand of fibrine in lymph, there would be 10 grammes of it derived from the liver and the kidneys. But double this quantity, or treble it, and only an insignificant quantity would result when compared with that which represents the quantity of of fibrine destroyed, or rather metamorphosed, in one day, in the liver and the kidneys. In fact, what is this quantity of 10, 20, or 30 grammes in comparison with 4000 or 5000 grammes? The trifling amount of fibrine, therefore, which passes by the way of the lymph through the kidneys and the liver may be safely neglected in the question under consideration.

If there be a daily transformation of 4 or 5 kilogrammes of fibrine in the blood traversing the digestive organs, the kidneys and the liver, it is manifest that there must be a formation of a similar amount of this element of the blood, since the proportion of fibrine in the normal condition remains nearly the same in the blood of the arteries and superficial veins.

But where is this large amount of fibrine produced? Experiments made in 1851, by myself, and the observations of Lehmann, two years since, appear to indicate the chief site of its formation. I have demonstrated that fibrine is developed in the limbs of the lower animals and of man, when separated from the body, if we inject them with defibrinated blood. Moreover, I have found that a larger quantity is formed, when the limbs are galvanized, during the process of injection. As the amount of fibrine produced under these circumstances is extremely small, and as, on the other hand, chemists had almost universally allowed that a larger amount of fibrine, both in man and the lower animals, is to be found in arterial than in venous blood, I was unable to draw any conclusion from my experiments. Lehmann has since shewn, however, that comparative experiments are fallacious in this respect, and that the blood of the lesser veins contains a notably larger amount of fibrine than arterial blood.

The following figures showing the proportion of fibrine, are the result of experiments upon five horses.

	I.	II.	III.	IV.	V.
Arteries	0.446	0.413	0.047	0.507	0.407
External abdominal Vein	0.639	0.604	.....	.....	.....
Jugular Vein	.....	0.337	.....	0.568	.....
Vein of the head	.....	.....	0.219	.....	.....
Digital Vein	.....	.....	.....	0.677	.....
Abdominal Vena Cava above the hepatic veins	.....	0.323	.....	.....	0.085

Several facts result from these analyses:—First, that the blood of the lesser veins (the external abdominal, a vein of the head, and a digital vein) contains from one to two parts in a thousand more fibrine than arterial blood; Secondly, that the blood of the inferior vena cava, after admixture with non fibrinous blood of the renal veins and of the supra hepatic veins contains from one to five parts in a thousand less fibrine than arterial blood. This latter result is confirmatory of the evidence which shows that fibrine disappears from the blood traversing the kidneys and the liver.

An increase of only six, seven, or eight parts in ten thousand, in the blood returning from the limbs, and from the surface of the head and trunk, would be sufficient in man to compensate for the loss of fibrine which takes place in certain abdominal viscera. I leave it for others to determine what influence any disturbance of the functions of the kidneys and of the liver may exert in the transformation and production of fibrine. My object has beeen to show that in all probability several kilogrammes of fibrine disappear daily in certain organs, and that an equivalent quantity of this constituent of the blood is produced in other organs. In accordance with these results, one of the functions of the kidneys and the liver would be to free the blood of its contained fibrine, and the formation of this element of the blood would take place in the capillaries of several organs but especially in those of muscular tissue. These several points, constituting a fertile field for exploration, are commended to the consideration of chemists.

M. B.

EXPERIMENTAL CRUISE OF THE FRENCH IRON-CLAD SQUADRON.

(*La campagne d'essais de l'escadre cuirassée.* By Admiral Xavier Raymond, in the *Revue des deux-mondes*, 1st January, 1864).

After a toilsome cruise of two months, the iron-clad squadron returned to Cherbourg on November 25th, 1863, bringing a rich freight of new ideas and studies, and fortunate in results obtained by it, and demonstrated by such an abundance of investigations and proofs as to leave us no longer in doubt as to the merits of the new navy. But a very short time ago, this navy was still much discussed. It was not uncommon to meet with very worthy officers, who, without denying its qualities as an instrument of war, thought, however, that they ought to make prudent reserves as to its nautical capabilities. Sceptical persons declared that these ships would not have sufficient height of battery, and that the least sea would stop their fire; that they would roll frightfully by reason of the enormous weight which they carried on their sides; that they would steer badly on account of their too great length; that they would find much difficulty in rising on a wave; that they would very rapidly go to pieces under the threefold influence of the weight of their hull, of the mutual action which iron and wood exercise, and of the galvanic currents which would certainly be set up between the iron of their plates and their copper sheathing; and other objections of the like nature. All this was said, and in good faith, not only because it is in the nature of things that every innovation should be opposed at its outset, but also because the Admiralty, with a jealousy which it is hard to account for, forbade any access to these new vessels, not only to people in general, but even to the officers who might any day be called to take command of them; and if rumors, incorrect, or even wholly unfounded, have been spreading through our navy about these iron-clad vessels, the Admiralty may take the blame entirely to themselves, for they have done their utmost for a long time past to hinder the truth being known. To believe in one's own infallibility is common enough on earth; but to imagine that it is possible to inspire others with the same belief, without taking any pains for that purpose, requires a dose of ingenuousness which can only be attributed to a set of people who, like the Admiralty, enjoy an experience doubly or triply non-professional. Why conceal one's works, if it were true that they had been successful? That was the thought which naturally occurred to the minds of most people. It was in vain that against this reasonable distrust it was attempted to set up the reports of officers who had sailed in these vessels, and were therefore almost the only persons who had a right to speak with authority. These reports were, and are to this day, kept secret, and though it was understood that they were in general very favourable to the iron-clads, still it was asked whether they did not contain some respectful criticism, some little postscript which reduced all their praise to a trifle. Besides, having regard to the instincts and sentiments of the profession, it was said that the command of these iron-clads had been very much sought after, and that it was no wonder that the officers who had gained them should reply to such a favor by a good will which made much of the good, and treated the weak points with indulgence. Add to this that while the sailor is always wedded to his frigate or his ship, the officer only too often looks but at the qualities of the ves-

sel in which he sails. Besides, how could any one be so hardy as to advance an opinion about ships which had been constructed specially for line of battle, that is, for service in a squadron, and yet which had hitherto sailed only singly, and had thus, in their mysterious trials, seemed to set themselves to avoid all control or comparison? Certainly the wisest had better wait before expressing an opinion.

To-day the veil is torn down. Our squadron of iron-clads has returned from a cruise which has put them to all the chances of the sea,—from a calm to one of the most violent gales which it is possible to encounter in the stormy waters of Brittany and England. During two months, and every hour of the day, they have been compared with each other and with the most renowned models of the old navy; and they have had for witnesses the three or four thousand men embarked in this trial-squadron, and the hundred and fifty officers in command, so that there is no longer any mystery about the matter. The superior authorities will doubtless trust us as little with the reports which will be addressed to them on this occasion as they have done in the past, but they cannot pretend to make secrets of results which have been accomplished under the eyes of thousands of spectators whom a lawful curiosity is to day earnestly interrogating. Plenty of facts have already been brought before the public, and by adding to what has already been related all that we have been able to collect, we now propose to study in our turn this interesting cruise, and to endeavour to draw from it the chief instruction it has furnished us. The national vanity will not suffer by this study; the expectations which had been formed of this squadron have been surpassed even more than confirmed, and the officers who had given it their confidence will have nothing to regret. The composition of the commission named by the ministry to direct or overlook this great experiment gave every guarantee that the investigation would be conducted with zeal and activity, with intelligence and impartiality; for if, on the one hand, there are found among the names we are going to cite, some whom we must consider personally interested in the success of iron-clad ships, on the other there are some who cannot be regarded as fanatical partizans of the new style. The commission consisted of Vice-Admiral C. Penaud, President of the Council of Works to the Admiralty, President also of the Commission and Commander of the Trial Squadron; M. Dupuy de Lôme, Councillor of State, Director of Material to the Fleet; Rear-Admiral Labrousse; Captains Bourgois, Chevalier, Lefèvre; and MM. Mariel and Robert, master shipwrights of the first class. The number of commissioners was thus equal to that of the ships of the division, so that there was always one on board of each, and all in turns were aboard of each, so as to study all the types and make all comparisons, thus placing themselves in a position to command a view of the whole and to control the calculations and reports, the work and observations which were made specially on each vessel under the care of its own *état-major*. In order to possess in the material itself the means of control and comparison which could not be disputed, the ministry added to the five iron-clads two old steamships of the line whose reputation was established in the fleet, and a corvette of 250 horse-power, the *Talisman*, commanded by Capt. Desaulx, and built by M. Normand, of Havre, on the model of Prince Napoleon's yacht, the *Prince Jerôme*. The

name of the builder and the model of this corvette are enough to indicate the confidence felt in her qualities. During the whole cruise she performed the very laborious service of tender (*mouche*) to the squadron. Of the two ships of the line, the first which arrived to take its place in the division was the *Napoleon*, commanded by Capt. M. A. Pichon. Ten years ago she was the pride of the French navy, and even foreigners acknowledged her as the most redoubtable and the finest, as well as the swiftest and most powerful ship that had ever figured in any squadron. I have elsewhere spoken of the exceptional service she did during the Crimean war, and it is not necessary to repeat it. After thirty years of a most active existence, and after having been employed with more success than any other in the hard work of towing, which tries vessels so severely, she is still remarkable for the perfect preservation of her form and lines, and is always distinguished for the strength she puts forth against wind and wave. During the heavy weather that the squadron encountered on its departure from Cherbourg, when this ship was seen, with its lofty masts, its three tiers of guns, and its bulwarks so high out of the water, attaining a speed of ten knots, more than eighteen kilometres, an hour, against a very strong sea, more than a sailor might regret the abdication, after so short a reign, which this noble specimen of naval architecture has had to undergo by reason of the progress of engineering art. Superfluous regret! The *Napoleon* has no armour; her guns, notwithstanding their number, would be of no avail against the iron sides of the meanest of the frigates which are sailing in her company. Her wooden walls would be set on fire or destroyed in an instant by the artillery of the weakest of the iron-clads. She was not attached to the experimental squadron in order to run this chance. Though she has lost her military *prestige*, she has preserved the nautical qualities for which she has always been celebrated; and she was intended to serve in this respect as a means of comparison with vessels whose fighting power is not disputed, but which are accused of not being good sailers. We shall see the results which a minute comparison has produced, but in order to appreciate them properly it must not be forgotten what the *Napoleon* is. She is a wooden two-decker of 90 guns of calibre 30, carrying a war complement of 920 men, having the same masts as our old sailing vessels of the second class, with a surface of sail of 2800 metres. Her engine is of 900 horse power, similar in every respect to that of the vessels against which she was going to be tried; her length is 70 metres, breadth 16 metres 80–100, her mean draught of water 7 metres 8–100, tonnage 5800, heighth of battery 1 metre 8–100; she carries one month's water, three months' stores and provisions, and 600 tons of coal.

The other vessel, which only joined the experimental squadron in the Brest roads, was the *Tourville*, and if what has been told me is true, the reason why she was attached to the squadron is an excellent proof of the sincerity and good faith with which these investigations have been conducted. During the few days which they spent at Brest after the gale of the 1st October, 1863, the experiment which they were going to make was naturally much talked of, and the advocates of new ideas showed themselves very well satisfied, as is also natural, but there were still some sceptical people, who were not willing to give in; they argued on grounds which seemed to a sailor's eye not to be altogether in fact unreasonable;

they said that this experiment was not to them so conclusive as it appeared to others, inasmuch as all the vessels which were going to be tried, being all the sons of one father, would necessarily, while they had the good qualities of the family, share also in its defects; it was by comparison with other models of different families that the virtues or the vices of the new constructions would be decisively brought to light; that the *Napoleon* was a very great sailer nobody disputed, but they did accuse her of having a very considerable roll; it was asserted, and this opinion was widely enough spread among our officers, that in the twofold respect of rolling and readiness of handling, the *Napoleon* was inferior to our old ships, those of the illustrious Sané, and particularly to his *Jéna*, the favorite vessel of Admiral Lalande. There was no way of getting the *Jéna* to compare, for she has been erased from the list of the fleet; but by happy chance, when these questions were being agitated with all the warmth of professional men, there happened to be at Cherbourg in the first class of the reserve, that is to say, capable of being fitted out in 24 hours, a ship which is a scrupulously exact reproduction of the *Jéna*. This was the *Tourville*; she differs from her predecessor only in the engine of 650 horse-power which had been put into her, but such is the respect that was paid to this celebrated model, that when it was necessary to transform the *Tourville* to a steamer, she was spared the operation of lengthening, which nearly all her mates then underwent. It was with the identical form of the *Jéna* and the same position of the centre of gravity, that after being razeed (for originally she was a three-decker of 110 guns) she achieved such a great reputation in the naval world. The *Tourville* has deserved the esteem in which she was held. In the Baltic expedition, she carried the flag of Admiral Penaud, and her performances there shewed her not to have degenerated from her glorious original. In effect she is a wooden two-decker carrying 82 guns and 850 men, one month's water three months stores and provisions, and 520 tons of coal. Her length is 61 metres, breadth 16 metres 88-100, mean draught of water 7 inches 80-100, and 4550 tonnage. She carries the masts of our old ninety-gun ships—the third class—as for instance the *Suffren*, with surface of sails 2650 square metres, and height of battery 1 metre 81-100.

Having thus within reach a vessel which afforded the means of solving once for all the questions so warmly disputed even by the most distinguished officers, a representation was made to the Admiralty who judiciously gave orders to fit out the *Tourville* under command of Capt. Lacombe. It was not however with the design of studying the military capability of the *Tourville*, nor her speed, nor the extent of her sphere of action; it was known before hand that she was certainly in these respects inferior to the ships of the new model, but she was reputed to roll relatively much less and to be handled with infinitely more readiness. In these two points, almost exclusively, she was employed as a means of comparison with the others, and to furnish data on them for our instruction.

So much for the wooden vessels and the reasons why they were added to the experimental squadron. To go on now to the iron-clads. They were five in number, and presented in their form and lines very perceptible marks of their parentage, formed however on three different models.

There was 1st the *Invincible*, under the command of Capt. Tabuteau. She is an

exact copy of the *Gloire* which we have elsewhere described at sufficient length, so that there is less need to enter into details in this place. We may merely repeat that she is a frigate of 36 rifled guns of calibre 30 (corresponding to Sir W. Armstrong's 100), and her engine is nominally of 900 horse power. Her length on the water line is 78 metres, breadth 17, mean draught of water 7 metres 75–100, height of battery 1 metre 82–100, weight of armor (including bolts) 840 tons, tonnage 5260, with a complement of 570 men, she carries one month's water, two and a half months' stores and provisions, and 675 tons of coal. Her ammunition is at the rate of 155 rounds for each gun, instead of 110, as in our last vessels, or 70 which was the regular allowance for the vessels of the first empire. A comparison between the *Invincible* and the *Gloire* shews only a slight modification of the masts and sails. Instead of being rigged entirely schooner fashion, the *Invincible* carries on her fore-mast a complete set of square sails (fore-sail, fore-top-sail, and fore top gallant-sail). On the other masts the rigging remains as it was, and the whole surface of sail is 1400 metres.

2nd. The *Normandie* commanded by Capt. Jaureguiberry is also a copy of the *Gloire*, and under the command of the late lamented M. de Russel, she had, as is well known, the honor of being the first iron-clad which crossed the Atlantic. She went to Mexico in 1862, and on her return she met near Madeira a violent gale which lasted for two whole days, and from which she came out in a way which proved her nautical qualities, and the solidity of her construction. Since this voyage she has had some changes in her arrangements; the cabins of her officers, which were previously placed along the sides of the frigate in deep darkness, have been brought amidships, under the light and air of the hatchways. It is now possible to read and write in the cabins without need to light the lamps, and the ventilation is much better; this is a great improvement to the comfort of the officers. At the same time it is more important for the investigation that concerns us, to note the reduction from 50 to 15 tons which the block-house she carried on her deck has undergone in weight and size, and also in her masts as compared with the *Gloire* and *Invincible*. The surface of her sails is still 1400 metres, but they are fitted as square sails on three masts of diminished height, and the length and scantling of the yards have also been reduced; the trim has also been slightly modified in furtherance of the same object, namely, the lowering of the centre of gravity of the frigate by lightening her above and throwing a greater quantity of weight below; this is one of the most important points to remark for the sequel.

3rd. The *Couronne*, commanded by Captain Penhoat, a forty-gun frigate of a special type; her form and dimensions differ from those of the *Gloire*, though it is easy to see that she has been created by the same genius. She has the bow and stern less sharp and more rounded, giving her a look more pleasing to the eye; her length is 80 metres, breadth 16 metres 70–100, her mean draught of water 7 metres 60–100, tonnage 6076, height of battery 1 metre 98–100, and with this draught of water she carries three months' stores and provisions, one month's water, and 650 tons of coal which could easily, in case of need, be extended to 1000 tons. Her surface of sail is 1620 metres, carried on three masts, two of which are square rigged. The especial distinguishing feature of the *Couronne* is

that her hull is of iron, built with plates two centimetres thick. To arrange the armour on this shell, it has been strengthened on the outside by a framework of ribs, the intervals of which are filled up by a thickness of teak of 28 centimetres, on which is placed a thickness of iron of 34 millimetres, which is itself separated by a second wainscoating of teak, 10 centimetres thick, from the plates of the armour proper, which is 10 centimetres thick on the water-line, and 8 above. So that at last we find the defensive system of this frigate to consist of a double thickness of wood of 38 centimetres and a triple thickness of iron of 13½ centimetres on the water line, reckoning in the thickness of the shell. She was proved at Vincennes in 1857, and gave good results as regards strength and solidity; it was expected that if she had to undergo the trial of artillery, she would resist better, by reason of the momentum of the projectiles being more easily dissipated by the difference of the successive media they would have to cross. On the other hand, it is proper to add that this ingenious system, whatever its defensive virtues may be in other respects, has the inconvenience of being sufficiently costly, so far that the *Couronne*, though its capacity differs little from that of its predecessors, has cost 20 and possibly 25 per cent more than the *Gloire*. However this may be, the *Couronne* is a very fine and elegant ship, and has distinguished herself in many respects during the trip. Not one single time, it is said, during the 36 days of actual sailing, did this frigate leave her place, or check the course of the squadron, to repair any one of those little damages which so frequently disturb the order of a squadron consisting of steamers, and affect the accuracy of their movements, and this is no mean title of glory for the *Couronne*. She was built at Lorient according to the plans, and under the personal superintendence of M. Audinet, naval architect. Her engine, which is of the type that naval genius has made common to such a large number of our vessels, and particularly on all our iron-clads, was made by M. Mazzeline of Havre.

4. The *Solferino*, and 5, the *Magenta*. We must speak of these two ships under the same title, for what is true of the one is true of the other. They have been built on the same plan, and any difference between them can only have arisen from difference in the mode of execution on the stocks. To exhibit the features which they have in common with the other ironclads, we may say that they are ships with wooden hulls, 86 metres in length, breadth 17 metres 30–100, draught of water when loaded 7 metres 90–100, tonnage 6796, height of battery 1 metre 82–100, engines nominally of 1000 horse-power, armament 50 breach-loading rifled guns of calibre 30, stored for 155 rounds apiece; carrying one month's water, 75 days' provisions, and 700 tons of coal by regulation; they have three masts which are rigged exactly as we have described for the *Invincible*, except that they have about 50 metres more surface of sail, 1450 instead of 1400. Lastly, the plates of their armour, having a total weight of 900 tons for each, are, like those of the *Gloire*, of a single thickness of iron, varying from 11 to 12 centimetres.

The *Solferino* and *Magenta* differ, however, in many respects from their predecessors. Although we continue, I know not why, to class them as frigates, they are in reality ships of the line in the strict sense that the term has always borne in the navy, that is to say, they have two covered gun-decks, 26 guns in the

lower, 24 on the main deck, and two chasers *en barbette* on deck. Their battery is more numerous, and also more concentrated, which may possibly be an advantage in some points of view; it may also be of service, partly at least, in certain states of the sea, when the lower guns, or those of frigates, would be paralyzed by the swell, although it seems little likely that under such circumstances the fire of the main-deck guns could be of real use, and I do not know any example of a sea-fight where such was the case. At all events, this armament by reason of its upper guns has certainly, in close combat, the advantage over frigates of a plunging fire, and this is not to be despised at the present day when the most vulnerable points of the ironclads are undoubtedly the shell below the water-line and the upper deck. The superiority of these ships over frigates, as far as artillery is concerned, is then a manifest and accomplished fact, as well on account of the number as the arrangement of the guns. At the same time, to obtain this superiority, it has been necessary to make some concessions to the natural force of circumstances. The most important of which is that the ship is not completely armed. Along the water-line, and over all the height of the orlop deck it is so, but above this it is only the guns which are covered by the armour. The fighting portions are without doubt under shelter; but forward and abaft, in both main and lower gun-decks, there are vast spaces which are no more protected than were the ships of long ago, and which offer considerable opportunity to the incendiary projectiles of the enemy. These are the weak points of the *Solferino* and *Magenta*. They could have been protected like the others only by adding three or four hundred tons to the weight of their armour; that is to say, it would have been necessary to change all the conditions of their build, and that, too, by increasing the size of vessels which are already greater than anything that had been seen before them. It should not be forgotten that the mean tonnage of the three-deckers, the kings of the sea ten years ago, did not exceed 5000 tons, and we have now reached nearly 7000 in the *Solferino*, 8800 in the *Warrior*, 10,000 or 11,000 in the *Agincourt*, (built by Messrs. Laird and Birkenhead) and 22,000 in the *Great Eastern*. This is very quick work, and we may be permitted to doubt whether the English have much to congratulate themselves on by trying to make more rapid springs than ours. The *Great Eastern* has not turned out prosperously either as an instrument of traffic or of navigation; and the other day the *constructor in chief* of the English navy, the able M. Reed, confessed publicly at Greenwich that the *Warrior* was not a success, owing to this very exaggeration of size. M. Reed said frankly (using the figures that I here repeat) that the *Warrior* would be a better sea-boat if she had 100 feet less length, that she would roll much less, and above all would steer much better. In every art where results are to be obtained, not by the exercise of the imagination, but by the application of the principles of the exact sciences, real and safe progress can only be made step by step, proceeding always from the known to the unknown, and not by abrupt jumps. This is especially true of the labors of the naval architect. He has not merely to deal with his own special art, and with the varying chances of the sea, but he must also deal with a crowd of other special arts, which may sometimes be mutually exclusive, and are almost always contrary in their requirements; and in this way the true spirit of his art is rather one of conciliation and perpetual compromise with all

the advances which are being made around him by the different branches of human science and industry. It may happen that, when some great discovery has been made in one direction, it would not be prudent for an artist to apply it in practice, because he may not know the means of making it harmonise with the other data of his art. In order to advance with any success in his own path, he must not only always base his calculations on acquired certainties, but, and it is here the most delicate point lies, he must never attempt anything beyond the limits of the mutual accordances which these certainties present. Thus the wish to get the double advantage of two gun-decks, and more guns than a frigate (properly speaking) carries, has necessitated the leaving large spaces unprotected by armour, both in the bow and stern and in the main and lower decks. It is to be feared that this is not very consonant to sound military principles, for, despite the excellence of the arrangements which have been made to combat this danger, the chance of fire is always there, and this is at once the most formidable and the most dreaded enemy of the sailor. No cannonade, be it as deadly as it may, produces in the sailor's mind anything like the effect of the simple cry of "fire!" And fire on board of an iron-clad would produce all the more effect on their minds because a belief in its incombustibleness is almost necessarily attached to the idea of the armour, and the sailors would fancy that they had been deceived. I know quite well what the remedy will be. Our builders, if they are not at present ready to build ships completely armour-plated, will soon be so, and the force of circumstances is pushing them on to it in spite of the resistance which financial considerations oppose to the project. In war the only economy is to ensure victory; and whatever be the price that ships completely clad in armor may amount to, it will have to be borne when our builders know how to make them. The same thing will happen as already has happened with the old sailing vessels and wooden steamers, which, starting in 1830 with the *Sphinx*, of 120 horse-power and four guns, became, in 1846, the *Napoleon*, of 900 horses and 90 guns, and, in 1850, the *Bretagne*, of 1200 horses and 180 guns. In the same way, at the commencement of this century, there was in all the European navies a large number of 50-gun ships of the line, two-deckers, like the *Solferino;* and since 1827 we have been putting on the stocks two-deckers mounting 100 guns. And again, in the same way, we have seen the merchant steamers starting from 600 tons and 160 horse power, which was their highest up to the year 1830, and now reaching 4000 tons and 1000 horses in the vessels of the great transatlantic lines. But I repeat that all this has only been done, and can only be done, progressively, by the advantage of time and investigations patiently pursued from step to step. Meanwhile, if there be a necessity of copying the model of the *Solferino*, would it not be possible to substitute iron for wood in the unprotected part of the side above the water-line? Unless there be some stronger reasons for avoiding this combination, it would have the very great advantage of considerably lessening the chances of fire. Be this as it may, and even if it cannot be considered very military to leave a part of the ship's side exposed without the defence of the armor to the incendiary missiles of the enemy, it is in fact quite certain that the *Magenta* and the *Solferino* have lost absolutely nothing, in a naval point of view, from carrying their two decks of guns. Much to the contrary, the sailing

qualities they have shewn exceed what their warmest admirers had expected of them, and, (which is not less valuable than their swiftness or the easiness of their roll) their decks afford accommodation for the men on board which is exceptional for comfort and healthiness. The unprotected part forward serves on the lower deck as the warrant-officers' cabin, and on the main deck for hospital; while the corresponding part aft contains the captain's cabin above, and the officers' below, each cabin having a port hole for air and light. Officers and warrant-officers have never before been so comfortably accommodated on board a man of war.

This is not all; these vessels are further distinguished from their predecessors by the form of their bow which is quite peculiar. Instead of forming, as in the *Gloire*, a kind of iron axe edge, the bow of the *Solferino* and *Magenta* is prolonged perpendicularly in the shape of an angle of which the vertex lies about a metre below the water line; or, in other words, their stem, instead of continuing its projection forward when parting from the keel, as is usually the case, takes on the contrary a direction backwards towards the interior of the ship, commencing from a point about a metre below the surface of the water. This arrangement has been made on these vessels in order to arm them with a beak or ram, and it is the most novel of their characteristic traits. The ram is fixed on the vertex of the angle we are speaking of, at the end of the armour which envelopes the whole ship along the water line, and in such a manner as to form one body with it and to gain from this union the greatest possible amount of solidity; it consists of a mass of cast iron of about 12,000 chilogrammes and appears at about 6 metres in front of the stem, in the shape of a hollow cone, with two long flaps attached, like the cheeks of a helmet, to the sides of the ship. Except at the extremity, the cone is hollow, but its walls, which are not less than 12 centimetres thick in their weakest point, are shaped on the inside so as to fit exactly to the wood-work of the vessel; the ram in fact is one with it.

This weapon, although it has not undergone the test of experience inspires naval men with very great confidence. Imagine a projectile of 7 millions of chilogrammes in weight; yet such is the part the *Solferino* would play in running down an enemy's vessel, and if she struck it on the beam there is no need to say what would happen. Further, the *Solferino* possesses a swiftness such that there are very few ships, (perhaps there are hardly 10 in the world that could be named) which could escape by flight from the shock of her ram; to fly would, in fact, be to place themselves at her mercy; the true plan of defence would, on the contrary, be to wait for the shock, and to manœuvre to avoid it at the very instant when the collision seems most imminent. The party seeking to avoid the shock should consider himself the centre of a circle, the circumference of which the assailant would be compelled to follow before finding his opportunity, and in this position the waiting vessel would probably have the advantage of facility in evolutions which would be relatively more rapid because much less space will suffice for his escape than the enemy would have to traverse before delivering his stroke.

In any great naval battle—and whatever may be the weapons employed all serious actions have always ended in a melée—the *Solferino* would certainly be able to fight with her ram; but we have yet to learn what damage she might do herself by this audacious enterprise. This is an experiment which has not yet

been made by any body with an exactness, and under the conditions sufficient to enable us to guess at the results even approximately. In other respects the ram does not seem to injure any of the nautical qualities of the ship unless it be during changes of course very slowly executed, and then it sensibly retards the quickness of the operation; but this is not a defect that we need practically take into account.

Such are the ships of which the experimental squadron consisted. It is only right to add, that the *Solferino* and *Magenta*, as well as the *Invincible*, the *Normandie* and the *Napoleon* are the work exclusively of a builder, M. Dupuy de Lôme, who has been designated in a document distributed by order of the Queen of England and signed by Admiral Spencer Robinson, Comptroller of the Navy, as "the most able designer of ships of war in Europe whose success has been so remarkable."

On the 27th September, at one o'clock, p.m., the squadron sailed from the channel of Cherbourg in search of one of the gales which almost always rage about the equinoxes, and which it was destined to meet sooner perhaps than it desired. For not only were the complements of men not completed, failing indeed of one-third of the regulation number, but they had hardly yet got into order, and many of the men on board were altogether strange to the new models, while some of the mechanics even among the masters, had never before seen fittings like those they had to superintend. Nobody would have disliked to have a few days of fine weather before them to enable them to look about them. From the 28th, however, the sea became so rough, and the breeze freshened with such strength that the vessels of the squadron in sight were all under their foul-weather canvass. On the 29th there was a lull; the sea went down, leaving only a heavy swell, and the wind fell, but changed during the day nearly all round the compass from N.W. to E., through S., which is an almost infallible sign of the weather they were going to have next day, and of the gale which was let loose with its full force during the night of the 30th Sept. to the 1st October, blowing steadily from the N.W. The squadron which had now sighted the lights of Ushant, and were then standing out to sea towards the Scilly islands, that is to say, going with the wind directly in their teeth, was dispersed by its violence and could not reassemble till the morrow, entering Brest on the 3rd to repair the damages inflicted by the storm.

The test was everything that could be desired, for they had certainly encountered one of the most violent of atlantic gales. The disasters which it caused on the coasts of Brittany and England are unhappily only the too certain proofs of its violence. The waves reached a height very rarely attained in these seas. By measurement on board the *Solferino* and *Magenta*, they gave a result of from 9 to 10 metres. This would be very considerable in any sea, and I find some memoranda of my own experience which do not leave me in any doubt of the value of such a figure. In the month of April, 1844, while doubling the Cape of Good Hope, that is to say at the beginning of the bad weather in those latitudes, I had the annoyance of being disagreeably knocked about during 16 consecutive days of foul weather, in the *Serène* frigate. At that time the naval mind was much piqued at M. Arago who had allowed himself some rather lively pleasantry at the expense of Admiral Dumont d'Urville, about a figure which the latter had

given him (perhaps a little loosely) for the height of the waves in the neighbourhood of the Agulhas bank. The Academician did not dispute what the sailor alleged, namely, that that is possibly the part of the globe where the waves in bad weather reach their greatest height, but the figures themselves he made fun of. We were all very anxious to try and decide the question, and the sea itself served us to the extent of our desires; the officers were animated with the most laudable zeal, and would doubtless have been very well satisfied if they could have been able to satisfy the Admiral, but, spite of all their good will, aided by the circumstances of the weather, it was not possible to exceed the maximum of 12 metres.

The storm, then, of the 1st October, was one of the most serious, and it did some damage. Let us now see what this amounted to.

Of the five ironclads which were attached to the squadron, there is not one which has undergone any damage that can be attributed either to their form or to the present plan of their construction, or to the workmanship or materials employed on their construction. All that they have suffered,—and on the whole it is but a trifle,—is independent of the question of the ship being of wood or iron, of the ship being armor-plated or not. They had some boats carried away. Granted; this is a proof only of the violence of the sea. The *Napoleon*, notwithstanding its advantage of a greater height above the water, lost two of them, while the *Invincible* did not lose one, and besides did not undergo damage of any kind; so also with the *Couronne*, except the loss of four boats. The *Magenta* and, still more, the *Solferino*, experienced accidents which might have become serious, but they arose entirely from damages in the system of pipes and secondary parts of their engines, so that these accidents prove nothing in the question. The *Normandie*, which experienced the roughest handling of any, shipped some water while she was in the trough of the sea, having been intentionally put there when the storm was at its height, and she carried away her fore top-gallant mast and jib-boom; but can we call these damages serious? And when, after having met with them, she was again put head on to the sea, she no longer shipped a drop of water.

This is the complete bill of costs against the iron-clads. All their hulls have remained uninjured, and after the most minute inspection it cannot be discovered that they have been at all shaken or have undergone any deflection.

The fate of the vessels not armour-plated was very different. The *Napoleon* had her bows stove in, while making head against the sea, and was compelled to go into port to repair. The *Talisman*, being less solid and strong, could not follow the evolutions of the squadron on the 28th, when it was making 10 knots against a head sea somewhat less than that which rose during the storm; she was then shipping water fore and aft, and her screw suffered so on that day that her captain during the gale was compelled to lay to and continue his course without engine to the rendezvous off Ushant. By a chance, curious enough, but especially instructive, the *Talisman* was the only vessel of the squadron fitted with a "well"—that is to say, a contrivance intended theoretically to unship her screw for the purpose of examining it, of preserving it in case of danger and repairing it in case of damage, and she was the only vessel of the squadron which had to go into dock, and that just in consequence of accident to her

screw which it was impossible to remedy even in the still waters of the harbour. They had to dry-dock her before she could again be put into condition to continue the cruise. May not this failure in the screw system proceed from a weakness or failure of connection caused in the stern of the ship by the very construction of the well?

On the whole, speaking as yet only of the casualties of the storm, the test that had been made shewed that the iron-clads had resisted the storm better than the others; that the damages undergone were in no way peculiar to them, and that they would have been able to repair them on the first return of calm weather. The wooden vessels, on the contrary, which had been compelled to bear up, that is to say, to abandon the struggle against the storm sooner than the others, had undergone damage which was special to themselves, and were forced to re-enter not merely the roads but the harbour and dock, and would have detained the squadron for seventeen days, while the others (even admitting that they would have found much advantage in re-entering the roads), would have been able to set out again after the time necessary to take in their coal, an operation which is, unfortunately, not yet an easy matter in the Brest roads in bad weather.

We have already obtained results of great importance, but the remainder of the cruise went to shew that our iron-clads possessed many other qualities which the chances of this first assay would already have led us to suspect without permitting us to consider them proved. The weather was singularly favourable during this second part of the cruise; it was always fine enough to proceed with all the investigations which entered into the programme of the commission, and it was sufficiently varied, both as regards force and direction of the winds, and state of the sea, for trustworthy experiments to be made under every combination. Lastly, the voyage was long enough in duration (35 days) and extent (about 1200 leagues, from Brest to Cherbourg, touching at Madeira and the Canaries) to authorize us in regarding the results obtained as being practical ones. We now proceed to mention the most important.

In the first place we may repel the accusation brought against the iron-clads of being deficient in height of battery, and in this respect being inferior to their predecessors. The figures quoted above have replied in advance to this objection; they show, in fact, that while the height of battery, in metres, was for the *Napoleon* 1.80 and the *Tourville* 1.81; for the iron-clads they were as follows:—*Normandie*, 1.82; *Invincible*, 1.82; *Couronne*, 1.98; *Solferino*, 1.82; *Magenta*, 1.82; and with these figures they carry from 650 to 700 tons of coal, the consumption of which would make them rise between 60 and 70 centimetres. Hence there is no reason for them to envy their predecessors in this respect. Doubtless if this dimension could be further augmented without doing injury to the other qualities of the ship, it would be better, but possibly too much importance is attributed to this advantage. The squadron fired their guns every day, and were able to do so in states of the sea where fighting would have been next to impossible. A sea fight only takes place in calm weather; when the sea is rough enough to cause a roll of from 10 to 12 degrees on each quarter, the fire of the guns becomes almost illusory, even with the best guns and gunners. In all naval history I do not know, either in a single fight or a great battle, of a defeat under-

gone in consequence of one of the combatants having his fire stopped by the sea, while the other was able to continue it by reason of the height of his batteries above the water.

The roll of a vessel plays an important part in this question, but before speaking of it, let me first say a word of the pitching (that is, of the oscillations in direction of the ship's length), because it is a point on which I think, at the present day, all are agreed. The pitching of the iron-clads, is, by universal testimony mild and easy beyond comparison. They have proved that they can keep their head up against the heaviest sea without falling off, even at a low speed, and can go before the wind without shipping seas over the stern, notwithstanding the sharpness of their build, and in both cases their roll is extraordinarily moderate. This was found to be the case for all of them under all circumstances of weather, wind, and sea. It is to these characteristic qualities they owe the comparative immunity with which they encountered the gale of October 1st, while the *Napoleon* had her bows stove in, and the *Talisman* labored heavily, shipped water over stern and bows, and experienced damage enough to send her to dock. This point may then be held settled.

The subject of the "roll," that is, the motion of the vessel transversely from side to side, has been much already and will doubtless yet be more discussed, but the present facts prove that the ironclads need not fear comparison on this head. Neither during the gale, nor during the fine weather that succeeded, did they roll more than the others; the transversal oscillations were not more in number, or larger in extent for them than the others. In fact, the problem is apparently altogether independent of the armour. For many reasons I consider it does not devolve on me to form a complete theory of the roll, its causes and effects; but one in particular would be sufficient to stop me from attempting it, which is, that the most competent men of the present day seem to be much divided on the subject. Our predecessors had only to deal with sailing vessels, and did not find themselves called upon to study this question deeply; it has become really of great importance only to steamers which have to keep their course independent of the direction of the wind and current, and of the state of sea and weather, or rather, to put it more strongly, have almost always to make headway in contradiction more or less complete to these elements. The reason why the modern ship is subject to a roll greater than the ancient, is that it is a steamer, having its propelling power within itself, and not that it is clad in armour. This is the first point that results from the trials we are speaking of.

Since then the question of the roll has acquired real importance, only within a short time back, it is not wonderful that the persons who have studied it should be, notwithstanding their merits, yet disagreed on the subject. With the public generally, and even with sailors, the belief is still firmly held that the number of rolls is determined by the more or less rapid succession of waves that lift the vessel, and that the magnitude of the roll is inversely proportional to the "stability" of the vessel. This is in fact the theory which would first naturally occur to the mind; but we now find some eminent men proclaiming that this theory is altogether false, and they draw from the results obtained during this cruise of the

iron-clad squadron some very forcible conclusions. In certain respects they have already upset the old theory by shewing that the most stable vessel is not that which rolls the least, and even that it may be one which has a very lively and distressing roll. The fact is now accepted, at least by the most distinguished sailors, but we may expect a very warm discussion when we assert, as the new theory does, that the number of a ship's rolls is absolutely independent of the state of the sea, and of the greater or less rapidity of succession in the waves; that each vessel ought to be considered as a pendulum for which, under a given arrangement of weights there is a certain invariable number of oscillations which is peculiar to itself, and that the intensity and rapidity of the waves do not affect the number but only the magnitude of the rolls; lastly, that the vessel which compared with others, has rolled the most one day, may be that which will roll the least on the morrow. This is what happens in the case of the pendulum oscillating normally, when it meets by chance in the agitation of the sea, a cause of motion concordant, harmonizing with, and isochronous to its own; the vessel will then astonish by the magnitude of its movements those who the day before, and yet, possibly, in worse weather, but less sympathetic somehow with her particular constitution, were admiring the gentleness of her roll.

If these notions are correct—and I repeat there has been observed during the trip a great number of facts in confirmation, and not one in contradiction of them; —If these notions are correct we see the bearing they have on the question of the roll of the iron-clads. They put the armour itself altogether out of the question, and reduce the discussion to bear only on the shape and on the position of the general centre of gravity of the vessel, including hull and loading. The question then being stated in these terms, is it true that the new ships, especially the *Magenta* and *Solferino*, which ought to be regarded as developed and perfected copies of the first models of the *Gloire*, have given in comparison to the vessels with which we are studying them differences in magnitude or frequency of roll, which would constitute in this respect a real cause of inferiority? No!—Such assertions cannot be maintained. Next to the *Talisman*, it is the *Normandie* which, of all the ships of the squadron, had the worst roll, and the example of this frigate will give us a useful lesson. When it was proposed to fit out the *Normandie* a report was generally spread, one knows not how or why, that this latter had a very heavy roll, and consequently it was wished to remedy this supposed defect, but opinions differed as to the nature of the remedy to be used. Some, and they were the smaller number, asserted that if it were true that the frigate rolled too much, this must be because she had too great stability, that is to say, that the weight accumulated in the lower part of the vessel was sensibly in excess compared to that above; it was necessary to bring about a better equilibrium by increasing the weight she carried aloft. Others, on the contrary, maintained that the frigate rolled because she had not stability enough; the motion of which she was accused was appealed to as proof of this deficiency, and to remedy it they proposed to do exactly the opposite of what the others advised, that is to say, to lighten the frigate above and thus lower her centre of gravity and consequently render her more stable. This last advice gained the day; the weight of the masts was lessened, and the block-house she

carried on deck was reduced from 50 tons to 15; but what happened? The frigate, far from having gained anything, showed herself during her voyage to Mexico, and the first part of this experimental cruise, more sensitive than ever the *Gloire* had been to the motion of the sea, and only became more quiet when they reversed the previous operation. In the Funchal roads they brought out from her magazine and gun deck, and put upon deck, a quantity of guns and balls to the weight of about 200 tons, and from that time to her return to Cherbourg, her centre of gravity having been raised by this operation, she had a shorter and easier roll, and thus recovered part of the mean difference which in this respect distinguished her from the other ships of the squadron. If this experiment is not conclusive it is at least very instructive, and has besides been confirmed by what was observed in the *Magenta*. This ship, constructed on the very same plan as the *Solferino*, gave, as regards rolling, results differing from hers, and less advantageous. They were attributed to two causes, namely, that the *Magenta* carried in her lower bunkers 50 tons more coal than the *Solferino*, and her upper works had been constructed with timber of less section than that which had been used on her consort, thus producing another difference in weight of about 50 tons more. She was not, therefore, loaded in as satisfactory a manner, having more below and less above.

Be this as it may, the following is the order in which the ships of the squadron are classed in respect of rolling. It is the mean result of very numerous observations made with extreme care, under conditions the same for all, and carried on from hour to hour, the figure set down for each hour being that of the greatest roll observed during that period. Beginning with that of the least roll, they are, *Solferino, Magenta, Napoleon, Tourville, Couronne, Invincible, Normandie.* This classification has some exceptions; for example, I may quote the 26th October, when the squadron, steering W.S.W., with four furnaces in blast, and a speed varying from seven to eight knots, was subject to a very heavy swell on the beam coming from the N.W., and had to make head against a tolerably fresh breeze from the southern quarter. The observations from hour to hour during this day from 6 A.M. to 6 P.M., give the order of the ships as regards increasing magnitude of roll, which was naturally under the circumstances very heavy.

	Inclination to		
	Starboard.	Port.	Total.
Solferino	17°.03	17°.25	35°.08
Magenta	18.12	17.58	36.
Napoleon	19.83	17.29	37.12
Couronne	17.95	19.73	37.68
Tourville	20.85	19.72	40.57
Invincible	19.91	21.54	41.45
Normandie	21.33	22.50	43.83

Besides the change in the order of classification, what is further remarkable in this table is the amount of the difference between the least roll, that of the *Solferino*, and the greatest, that of the *Normandie*. This difference is 8.°75, or only

4.°37 on each quarter, and this was previous to the redistribution at Funchal of the *Normandie's* loading. Compared with the *Invincible*, the amount of the total difference is no more than 6.°47, or only 3.°18 on each quarter. The observations which had already at different times been made on the number of rolls corresponding to each vessel, were continued on this day, and gave the following number per minute: *Solferino*, 9¾; *Magenta*, 10; *Napoleon*, 10½; *Tourville*, 10¾; *Couronne*, 12; *Invincible*, 12; *Normandie*, 12½; *Talisman*, 15. These figures are very nearly the same as had been observed under very different circumstances of weather and sea, notably on Sept. 28th. In the various notes communicated to me, I observe that attention is particularly called to this almost constant recurrence of the same numbers. One of them, written by a most distinguished officer, contains a sentence which I will quote verbatim. "These numbers are sensibly constant for the same vessel, whatever be the magnitude of the rolls, from the least to the greatest. I have observed it repeatedly." But one day occurred (probably an exception) which totally upset the order of classification determined by the greatest mean. On Wednesday, 18th Nov., after the departure from Funchal, the squadron were steering N.E., with two furnaces in blast up to 3 p.m., and then with three till evening, and a light breeze between S. and S.E. was blowing on the quarter beam. With the help of its sails, it attained in the morning a speed of 7 or 8 knots, and in the evening 8 or 9. The weather was very fine, and the sea quiet, with only a long and gentle swell on the beam. Under these circumstances (and I think it of use to particularise the details because it touches on a problem in navigation, very curious and little known) the magnitude of the rolls observed from hour to hour were as follows:

Rolls.	Morning, A. M.						Mean.	Afternoon, P.M.						Mean.
Observed at	7	8	9	10	11	12	A. M.	1	2	3	4	5	6	P. M.
Invincible	5°	5°	4°	5°	8°	8°	5°·83	8°	7°	7°	8°	10°	13°	8°·83
Couronne	4½	4	4	4	4	5	4·25	9	11	9	9	19	21	13·
Magenta	4	4	3	7½	9	8	5·92	7	11	14	11½	14	20	11·25
Solferino	5	5	5	7	10	10	7·	8½	11	15	14	13	11	12·
Normandie	8	8	6	7	7	7	7·16	8	12	8	15	13	13	11·50
Napoleon	4	3½	4	6½	10	8	6·	9	11	12	16	17	17	13·76
Tourville	4	5	5	7	9	10	6·66	9	10	14	16	23	21	15·50

The result of this table is to class the ships in the following order of increasing magnitude of roll, for the 12 hours: *Invincible*, 7°.33; *Couronne*, 8.12; *Magenta*, 8.58; *Normandie*, 9.33; *Solferino*, 9·37; *Napoleon*, 9.83; *Tourville*, 11.08.

The abundance of these details will I hope be excused, but as they have never before been studied with such care and completeness, and as they tend to throw a new light on one of the most important and most controverted questions of naval architecture, I have thought it necessary to enter into them. Now let

us leave aside the theoretical question. After what we have noted, we may be permitted to assert that ships of the new model, even such as they are, are not subject to a roll greater or more distressing than that of the best of their predecessors. Without discussing the assertions to the contrary, I think they depend, that is so far as they are correct, on exceptional facts which would require to be carefully studied and analysed. Such facts occur as frequently in the life of the sailor as in that of other men, and without wandering from my subject I may here quote an example striking enough. The log of the *Tourville* shows that on the morning of Oct. 28th, the weather being quite calm, she was struck by several seas which would not only have flooded both the gun-decks, if the ports had been open, but actually rose above the nettings, and wetted the chimney in the very centre of the ship. None of her consorts experienced anything of the kind. How was this? I cannot give an answer, but I should be very chary of drawing a conclusion unfavourable to the qualities of the *Tourville*, and yet I suspect that if the same had happened to the *Normandie*, which has been so severely attacked, she would probably have been much abused for it.

It has then been demonstrated that our iron-clads have an infinitely more easy pitch and a not larger roll than the best vessels before them, which is a very satisfactory result; but better still remains behind. It seems also to have been demonstrated that they would doubtless be improved, even in this simple point of view, if we increase to some amount the weight they at present carry aloft, and this may have results of extraordinary importance by increasing greatly not only their nautical qualities, but also their power in a military point of view. They have displayed, under canvass, qualities altogether unexpected, even by their warmest partisans, and it would therefore naturally occur to any one that if there is a certain amount of weight to be added to them in their upper parts, it could not be disposed of with more usefulness than by increasing the strength of their masts and the surface of their sails. That this would be well worth while, we see from the results that have been obtained relative to speed and facility of evolution. Previous to this, the sails of an ironclad had been generally considered as a last resource in case of injury, when by the disabling of her engine, the ship would be forced to make for the nearest port before the wind. To the great astonishment of all the world, we have, however, seen the iron-clads under canvass for whole days and nights, and keeping their regular distances in the squadron without disarrangement. It might possibly be imagined that in order to secure the pleasure of having to state facts so little foreseen, certain courses were chosen which are easier to keep than others, but it was nothing of the sort in fact; the iron-clads were kept under canvass on every course, even close to the wind. In beating to windward, they were able to go about with the utmost ease, and to wear more slowly, but still surely, without using their engines, and under the sole action of their sails. So well did they succeed, that in the channel between the Azores and the Canaries, although surrounded by land, and therefore in the midst of dangers, the Admiral put them under canvass and made them tack and wear night and day, the squadron being in two lines at intervals of three or four cable lengths—(600 to 800 metres)—without a single accident occurring. Is it necessary to add that the *Tourville* herself many times missed stays, while the

ironclads made the evolution easily? One circumstance which will seem still more extraordinary is that at the height of the gale of October 1st, the *Solferino*, having disabled her engine through some damage in its piping, lay to with her sails alone from 9.30 a.m. to 1 p.m. So little had the possibility of such a feat been contemplated, that the Solferino had not even been fitted with the sails ordinarily used for this purpose, and it was only after her return to Brest that they troubled themselves to give her the set of sails proper for this case.

There is no need to enlarge on this point, so I shall quote but one of the tables where the speed under canvass is noted in knots per hour: *Napoleon*, 8·3; *Tourville*, 7·4; *Magenta*, 7·2; *Couronne*, 7·1; *Solferino*, 7; *Normandie*, 6; *Invincible*, 6. If we take into account the difference of displacement, that is, the weight carried, and of the surface of sail, that is, the means of propulsion, these results are more than satisfactory.

As success makes people ambitious, we can easily understand the readiness with which sailors seize on the idea of enlarging the masts and sails on the iron-clads. On the one hand, this would augment the sources of safety, speed, and freeness of motion, and regain, at least, in part, the advantages which were thought to be lost. On the other, it would develope to an amount hard to judge of, the sphere of action of the new vessels. All this is true, but there is a limit which military considerations will not allow us to overstep at any price. It is known that the screw has the dangerous property of attracting to itself everything that floats alongside a vessel, and that small objects, of little consistence or hardness, may, precisely because they are so, disable this organ of propulsion when they get entangled in its parts. Consequently, the screw-ship of war should have the power before going into action of unshipping in a few minutes her masts and rigging.—Consequently, also, her masts and rigging must be of a very simple character, admitting of being shipped and unshipped with the utmost ease. This necessity points out a limit to be observed, and I may be here permitted to recommend to the notice of those whom it concerns, an idea of English origin which enjoys a large share of favor among our neighbours. The English, on their iron-clads, make the lower masts of cast-iron, and these not only satisfy all nautical and military requirements, but, being hollow, are also used as a means of ventilation, another condition to which we cannot pay too much attention, as it exercises a very important influence on the health of the crews.

To make our account of the manœuvring of these vessels complete, we must add a few words as to the experiments made in turning them. They obey their helms in the most satisfactory manner, and in all the letters I have seen, I have not found a single observation which can be interpreted to their disadvantage. Their extreme length, however, causes them to describe in their evolution circles of larger radii than shorter vessels do. This was known beforehand, and the only ground for surprise is that the difference was not greater, especially in the ships armed with the ram. A comparison of the vessels of the squadron classes them as follows, in this respect: the *Tourville* in the first place; second, *Couronne* and *Napoleon*; third, *Invincible* and *Normandie*; fourth, *Solferino* and *Magenta* The radius of the least circle described by the last two was 380 metres, while that of the *Couronne* was only 305.

As I have already described the engines elsewhere, I shall only revert to them here for the purpose of confirming the axiom of steam navigation, that the most powerful engine is also that which while giving the highest speed yet practically costs the least. The *Napoleon* had proved this in the Crimean war, where she alone did more service than many vessels together; and the present experiments have made this truth still clearer if possible. The *Napoleon*, with tonnage 5200 and engine of 900 horse power, that is, one horse power to 5·8 tons, was beaten in the trials of speed by the *Magenta* and *Solferino*, whose engines of 1000 horses give 7 tons to the single power. In all the trials, with 2, 4, 6, or 8 furnaces, these two vessels invariably headed the list, and in comparing the others with them, not at their highest (for the others could not have kept up then) but at a moderate speed, the consumption of coal was remarkably in their favor; thus there was more effect produced and less expenditure. Relatively to the *Tourville*, of 650 horse power and 4550 tons, the difference is surprising. It turned out that, during the whole cruise, the *Tourville* was obliged to have a greater number of furnaces in blast than the rest of the squadron, so much so that when the rest, at the completion of the experiment, had still enough coal in store to return to Cherbourg with four furnaces going, the *Tourville* had exhausted her stock, and was obliged to make for Lisbon to take in more. This advantage even in ordinary navigation cannot be too highly estimated, and still more so in a real campaign, for the sphere of action of a steamer is one of the most important elements of its power. The *Solferino* with two furnaces going, and a rate of 10 knots, consumes 22½ tons of coal per day; this makes her sphere of action 4500 marine miles or 1500 geographical leagues, and her regulation provision of 700 tons would be enough for thirty days' consumption at this rate. With the same number of furnaces, but increasing the fires so as to attain a rate of 9 knots (which she has actually done), her consumption is increased to 1560 kilogrammes per hour, or 37,440 per day, and the above provision would serve for a consumption of more than 18 days, and a run of 4050 miles, or 1350 leagues. With four furnaces she attained a speed of 11 knots, averaging 47 tons of coal per day, and this would last for 15 days, and a run of 3960 miles, or 1320 leagues. With six furnaces her mean rate was 12.4 knots, and her consumption 94 tons, reducing her time to 7½ days, and her run to 2235 miles or 745 leagues. With all eight furnaces going she reached a mean speed of 13.9 knots with a daily consumption of 138 tons, under which circumstances her regular provision would last five days, and her run be reduced to 1668 miles or 556 leagues. During her trial with eight furnaces, she maintained, by keeping up her fires, for more than an hour a speed exceeding 14 knots, her engine making 57 turns of the screw per minute; and on the other hand, by reducing the action of her engine to the lowest, the point it could not exceed without stopping altogether, she still reached a speed of 8 knots with only 12 turns in the minute.

All this is very encouraging, but there is one point on which I must exercise some reserve. Beyond doubt, the nautical qualities of the ships, their speed, their facility of evolution, the ease with which their engines accomodate themselves to a number of combinations, the amount of resources of all kinds they can accumulate between their own sides, are important, or even the principal, conditions of their military value; nevertheless, there is another question which, on the great day of trial, will rise to the first rank in importance. I mean the power of their

guns. I still firmly believe that the guns with which our iron-clads are armed, are superior to those employed in any other navy, but I am sorry to see that for two years past we do not hear of any process recorded as having been made in marine artillery, and I am still much more sorry to hear that we are departing from the fruitful path we were treading with so much profit to ourselves. It is said that we are quitting this path in order to throw ourselves upon guns of such weight and calibre that no engineer at present, I believe, could construct them except indeed as experimental studies, devoid of practical value. I feel a very strong current which is carrying us in this direction and which threatens to paralyse completely the progress we had made in following the only course which in this class of facts can conduct us to sure results. Within a very short time, by proceeding at each step from the known to the unknown, we had successively given to the navy the rifled cannon, the *grain de lumière* which preserves the piece indefinitely, the hooped cannon which allows an immense economy of material, and the loading at the breech, which has undergone the test of more than 20,000 shots with but one accident, and that arose from inexperienced gunners forgetting to close the breech; and lastly we had the real piece for power in the *Marie-Jeanne* which with 30 calibre and a weight of only 5800 chilogrammes, pierced without fail plates 12 centi-metres thick at 1000 metres distance. Up to the present time no other gun has effected this, and after firing 300 shots she is not yet the worse for it to a degree worth mentioning.

This was the point we had reached in August, 1861, but there we appear to have stopped, and it is now proposed to abandon all this in order to learn from the Americans and English how to make at the first jump guns weiging 15 or 20 tons, or even more. Foreign example is exercising on our lively imaginations an influence which threatens to destroy our equilibrium. The large figures that are quoted to us are turning a number of heads who forget to ask what serious result these large figures have produced. I know of only one, and that is our proved incapacity for making guns of 20 tons which shall be actual weapons of war, just as we are also incapable as yet of building ships of 20000 tons which shall practically succeed. Ought not, for instance, what has passed at the siege of Charleston to open everybody's eyes, and disabuse the most darkened understanding? Is there no lesson in the figure of 440 pounds given as the weight of projectiles which bombarded for 150 days the old fort Sumpter without rendering it untenable by the Confederates? Is it in France that we ought to be discussing such things—in France, where we saw at Fort Liédot some light but powerful pieces of the modest calibre of 24, at 1300 metres distance, and in 260 strokes, open a breach in a rampart of masonry, which they could not even see, because it was hidden from view by the glacis having been elevated nearly to the height of the crest of the parapet? Or ought we to allow ourselves to be turned out of our progressive course by the alleged 300 and even 600 pounders which Sir W. Armstrong constructs by manipulation in profound secrecy, when we see that in England his 110-pounder, corresponding to our calibre 36, is declared at the least "suspect" in the most solemn investigations, and that, in their own despite, the English navy is reduced to arm its frigates with the old smooth-bore 68 pounder? The English government has published on this question two enormous volumes of

official investigations and reports, and what do we find there? We find that Sir W. Armstrong himself never claimed to offer to the government anything more than a large rifled light piece (*grosse carabine rayée*), loading at the breech, and discharging a 12-pound ball, which corresponds to our calibre 4; but when, after the success of this piece had been established to the satisfaction of the government, he was pressed to make a gun of 32, he replied that he was not prepared, and requested 7 or 10 years to study the question. If he has meanwhile attempted still greater calibres, it has been under the pressure of government, and not with his own good will, except that he did not wish it to be said he had declined a service which others believed themselves able to render. His language on all these points is as modest as it is sensible. Let us pay respect to his patriotism, but let us not launch headlong on the course the English government has so rashly pursued. If this course was the correct one, the Turks, with their big guns of the castle of the Dardanelles, ought to be considered the first gun-makers in the world. To recur at the present day to their traditions seems to me as little reasonable, as if we were to let ourselves be influenced by what the Americans relate of their iron-clads, and were to abandon the magnificent ships which have given us such unexpected results in order to copy the *Monitors*, which cannot keep the sea, or the *Weehawkens*, which founder in the smooth waters of a roadway, or the *Keokuks* which are sunk at 750 yards distance by the round balls of General Beauregard, who refused the guns said to be 800-pounders which they wanted to send him from Richmond.

In order to complete our task, it would have been necessary to compare the results obtained by our ironclads with those obtained by the English; but the means of this comparison are wanting. The English government has not, to our knowledge, published any report of the two cruises that the *Warrior* and her mates made in the same seas as our own. Whenever the government has been questioned on the matter, it has replied that the reports were very satisfactory, but beyond this, its reserve has been almost complete. We cannot then institute this comparison, but, after what has been said, we think ourselves authorised in asserting that our navy need not fear *any* comparison; that its progress has been continuously in advance, and that its works, while being developed as they have been, from the *Gloire* and *Solferino*, and incessantly enriched by the adoption of every valuable invention, preserve a harmony and unity which are also very precious qualities. Certainly we have not reached perfection, but it seems to me that it is not presumption to believe, that if we had our choice from the navies of the whole world of the best they can offer, we should not find five ironclads which could do all that the five ships we have been speaking of have done, and especially with the same uniformity. It is only just to add that a great part of this success has been due to Admiral Penaud and the officers under his command. The activity, talent, and good-will which have been displayed are worthy of all praise, and we are happy in the acquisition of such men to teach us all that the works of our naval architects are worth.

J. B. C.

REVIEWS.

Geological Survey of Canada. Report of Progress from its Commencement to 1863. By Sir W. E. Logan, LL.D., F.R.S., F.G.S., Director; Alexander Murray, Esq., Assistant Geologist; T. Sterry Hunt, M.A., F.R.S., Chemist and Mineralogist; and E. Billings, F.G.S., Palæontologist. Montreal: Dawson Brothers; London, Paris, and New York: Baillière. 1863.

This important volume, so eagerly looked for both at home and abroad, amply sustains the expectations created by its announcement. Of a far more complete character than the ordinary Reports of Progress which have preeeded it, the present Report exhibits a condensed view of the results of our Geological Survey, from the commencement of this work in 1843, to the close of 1862. The results in question, methodized and systematieally arranged, form a complete treatise on the geology and mineral wealth of the Province: only requiring a little preliminary knowledge of geological details—such as may be gained in the lecture-room, or by the study of explanatory works—to be properly understood and appreciated by the general reader. The presence of a large number of woodcuts, chiefly illustrative of organic remains, adds much to the value of this Report, and a series of maps will shortly be issued in connection with it. One of these, already completed, is a coloured geological map of Canada; and another will exhibit the distribution of the surface or Post-Tertiary formations—the clays, sands, calcareous tufas, and other comparatively modern deposits, which make up the principal portion of our soils. A map of this kind has long been a desideratum. Apart from its utility in engineering, draining, and other similar operations, it will prove most serviceable in an agricultural point of view. In its compilation, the officers of the survey have been materially assisted by Mr. Robert Bell, a young Canadian naturalist, first brought prominently forward by Sir William Logan, and lately elected Professor of Natural Sciences in the University of Queen's College, Kingston.

As constant reference has been made to this Report, and many of its conclusions noticed, in a series of popular communications on the Geology of Canada, published in recent numbers of our Journal, we purpose, in the present place, to give merely a general analysis of the contents of the volume, and thus to take our part in calling attention to the great claims of the work to public recognition.

After a preface of considerable length, explanatory of the origin, organization, and general progress of the Survey, the Report opens with a very elaborate sketch of the physical characteristics of the country, from the Gulf of the St. Lawrence and bleak wastes of Labrador, to the plains and forests of the far north-west, beyond the shores of Lake Superior. This interesting and exceedingly instructive sketch, from the pen of the Director of the Survey, is followed by a series of chapters in which the various Azoic and succeeding rocks of the Province are described in great detail. Amongst other new facts, a point of much interest, in connexion with the Laurentian strata, is the announcement of a probable want of conformity between the lower gneissoid beds and the overlying anorthosites, leading to the recognition of a third Azoic subdivision, or one of an intermediate position between the Laurentian and the Huronian series. Much interesting information is also given with regard to the upper copper-bearing series of Lake Superior, and the apparent identity of these rocks with the Potsdam and Quebec groups of the east. The abnormal position of the Quebec strata is likewise distinguished and illustrated very fully; and the subject is still further elaborated in a subsequent chapter. The materials for this portion of the Report have been collected chiefly by Sir William Logan, Mr. Murray, and Mr. Billings; and the fossil illustrations (with the exception of some figures by Dr. Dawson, in illustration of the Devonian plants of Gaspé), are by the latter observer. Towards the close of the volume, Mr. Billings has also furnished a complete and most useful list of all the fossils of our Lower Silurian series. Those of our succeeding formations will undoubtedly be given in forthcoming Reports.

In the seventeenth and three following chapters of the present work, the mineral species of Canada, and the springs and waters of the Province, together with the chemistry of our Sedimentary, Metamorphic, and Eruptive Rocks, are brought under review. This portion of the Report, due to Professor Sterry Hunt, exhibits much accurate research, and contains a large amount of information of an exceedingly interesting character. The numerous analyses given in connexion with these questions, are not the least important part of Professor Hunt's contributions. To the same author, also, belongs the credit of a large portion of the succeeding chapter of this Report, comprising a detailed view of the economic geology of Canada. Readers who seek especially for practical results, will find all they can desire in this chapter. Full

details are given respecting the distribution of our metallic ores, the metallurgy and general working of these, together with a large amount of information on the applications, &c, of phosphate of lime, iron ochres, peat, and other economical materials occurring within the Province.

Finally, the Report closes with a long and systematically arranged description of the Post Tertiary or surface formations. In connection with this, a useful table is appended of the directions of glacial striæ, as observed throughout a wide range of Canadian localities, extending from west longitude 84° 29′ to 59° 12′, and from the parallel of 43° 2′ to that of 50° 36′. In our popular exposition of the Post-Tertiary deposits of Canada, published in a recent number of the *Journal*, and written some months before this portion of the Report came into our hands, we subdivided the deposits in question into three series, viz: 1, *Glacial* deposits (Lower Drift clays, sands, and boulders); 2, *Post-glacial deposits* (upper clays, gravels, and sand, or re-arranged glacial materials, containing fresh-water shells in Western Canada, and marine remains in the eastern part of the Province); and, 3, *Recent deposits* (Calcareous tufa, shell marl, bog iron ore, ochres, peat). The same order of arrangement, but with necessarily fuller elaboration, is followed by the Survey, as exhibited in the annexed table, extracted from page 887 of the Rport:

III.

Shell marl, calcareous tufa, peat,
Ochres, bog-iron and manganese ores.
Modern alluvions.

II.

	Western Canada.		*Eastern Canada.*
2.	Algona sand.	2.	St. Maurice and Sorel sands.
	Artemisia gravel.		Saxicava sand of Montreal,
	Saugeen fresh-water clay and sand.		Upper sand and gravel of Beauport.
			Upper Champlain clay and sand of Vermont.
1.	Erie clay.	1.	Leda clay of the St. Lawrence and Ottawa.
			Lower shell-sand of Beauport.
			Lower Champlain Clay of Vermont.

I.

Boulder formation or glacial drift.
Auriferous Drift of Eastern Canada.

The undoubted value of the earlier Reports of the Survey has long been recognised, both at home and abroad, by all whose judgment, in matters of this kind, can have any claim to our acceptance. The present Report, embracing, as it does, the results of all earlier explorations, and comprising in itself so much that is new to science, cannot fail to meet with equal recognition; and to attract, still farther, the attention of industrial art to the vast stores of mineral wealth that yet remain unworked within the limits of the Province.

CANADIAN INSTITUTE.

SESSION—1863-64.

FIRST ORDINARY MEETING—5*th December*, 1863.

REV. H. SCADDING, D.D., in the Chair.

I. *The following Gentlemen provisionally elected by the Council during the recess were balloted for, and their election confirmed,—viz.:*

JOHN GORDON, Esq., Toronto.
M. MCDERMOTT, Esq., Chicago.
JOHN HALL Esq., M.D., Toronto.

II. *The following Papers were read:*

1. By the Rev. Prof. W. Hincks, F.L.S., &c.:
" On Wehoitchia."

2. By Prof. E. J. Chapman, Ph. D.:
" On the detection of ordinary metals, in mineral bodies, by the aid of the common blowpipe and other cheap, portable and easily procurable apparatus, with illustrative experiments."

SECOND ORDINARY MEETING.

12*th December*, 1864.

REV. J. MCCAUL, LL.D., President in the Chair.

I. *The following Gentlemen were elected Members:*

CHARLES P. WILLIAMS, Esq., Philadelphia, U.S.
A. M. ROSEBRUGH, Esq., M.D., Toronto.
FRANCIS L. CHECKLEY, Esq., Toronto.

II. *List of donations for the Library received during the recess was laid on the table,—See Annual Report.*

III. The nomination of office-bearers for the ensuing year took place.

IV. *The following Papers were read:*

1. By the President:
"On ancient Glandes."

2. Doctor Morris exhibited and made some remarks on insects captured by him during the last summer.

THE ANNUAL GENERAL MEETING.

19*th December*, 1863.

The President Rev. J. McCaul, LL.D., in the Chair.

I. *The following Gentleman was duly elected a Member*:

David Tucker, Esq., M D., Toronto.

II. A ballot having been taken for officers of the Institute for the ensuing year, the following Gentlemen were declared duly elected,—viz.:

President,	Rev. J. McCaul, LL.D.
1st Vice-President,	S. Fleming, Esq., C.E.
2nd "	Rev. Prof. G. P. Young, M.A.
3rd "	B. R Morris, Esq., M.D.
Treasurer,	D. Crawford, Esq.
Recording Secretary,	G. H. Wilson, Esq.
Corresponding Secretary,	U. Ogden, Esq., M.D.
Curator,	H. Y. Hind, M.A., F.L.S.
Librarian,	Rev. H. Scadding, D.D.
Council,	D. Wilson, LL.D.
"	M. Barrett, Esq., M.D.
"	Rev. Prof. W. Hincks, F.L.S., &c.
"	T. C. Keefer, Esq., C.E.
"	Prof. H. Croft, D.C.L.
"	J. Bovell, Esq., M.D.

III. The Report of the Council for the year 1862–63 was read and unanimously adopted.

THIRD ORDINARY MEETING.

9*th January*, 1864.

The President, The Rev. J. McCaul, LL.D., in the Chair.

I. *The following Gentlemen were elected Members;*

W. Howland, Jr., Esq., Toronto.

J. Langstaff, Esq., M.D., Richmond Hill.

II. *The following donations for the Library were announced, and the thanks of the Institute voted to the donors:*

From the office of Routine and Record, Quebec. The statutes of Canada, 1863 1 Vol.

From Sir W. Logan, F.G.S., Montreal. The Geology of Canada, 1863. 1 Vol.

III. *The following Papers were read:*

1. By the President:
"The Annual Address."

2. By Prof. G. T. Kingston, M.A.:
"On the annual and diurnal distribution of the wind at Toronto."

FOURTH ORDINARY MEETING.

16th January, 1864.

The President, The Rev. J. McCaul, LL.D., in the Chair.

I. *The undermentioned Gentleman was elected a Member:*

F. T. Jones, Esq., Barrister, Toronto.

II. A donation for the Museum was presented by John Laidlaw Esq., per S. Spreull, Esq.

A specimen of Coal from Dunn Mountain near Nelson, New Zealand.

III. *The following Papers were then read:*

1. By Doctor Rosebrugh:
"On the ophthalmoscope, a new instrument for viewing and photographing the deep structures of the living eye, with illustrations."

2. By J. P. Clarke, Mus. Bac.
"On a new method of propelling steam vessels and canal barges, with models."

FIFTH ORDINARY MEETING.

23rd January, 1864.

Vice-President, S. Fleming, Esq., C.E., in the Chair.

I. *The following Gentleman was elected a Member:*

Hon. John Ross, M.L.C., Toronto.

II. *The following donations were announced, and the thanks of the Institute voted to the donors:*

FOR THE LIBRARY.

By James Hubbert, B.A.

"Ancient Gems." 1 Vol.

FOR THE MUSEUM.

By His Excellency the Governor of New Brunswick, per S. Fleming, Esq. C.E.

Specimen of albutite and other minerals. 5.

III. *The following Papers were then read:*

1. By the Rev. Prof. Hincks, F.L.S.:
"On continuation of observations on the systematic position and affinities of certain tribes of Birds, the Fissarostræ Group."

2. By James Hubbert, B.A.:
"On the Latex and Laticiferous vessels of Plants."

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—FEBRUARY, 1864.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 m. 33 s. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.			
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M	2 P.M	10PM	ME'N		6 A.M	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N
					°	°	°	°	°								
1	29.262	29.230	29.530	29.3452	36.3	37.4	36.7	36.88	+13.00	.202	.187	.171	.186	.94	.84	.78	.85
2	.450	.328	.333	.3467	34.5	36.3	34.5	34.52	+10.67	.174	.160	.175	.165	.87	.75	.87	.83
3	.340	.351	.388	.3615	29.5	33.1	28.4	30.20	+ 6.43	.144	.130	.134	.136	.87	.69	.86	.81
4	.207	.042	.081	.1060	25.5	35.2	32.7	31.15	+ 7.47	.118	.172	.172	.155	.86	83	.92	.87
5	.113	.230	.379	.2517	32.7	34.5	31.6	32.47	+ 8.88	.172	.157	.156	.161	.92	.79	.87	.87
6	.408	.409	.495	.4440	27.7	30.2	27.0	28.17	+ 4.65	.128	.157	.129	.135	.84	.93	.88	.87
7	.412	.223	—	—	24.1	32.4	—	—	—	.107	.146	—	—	.82	.79	—	—
8	.064	.212	.390	.2420	28.8	25.5	15.0	22.68	— 0.68	.144	.104	.075	.104	.90	.75	.87	.83
9	.481	.557	.702	.5982	8.6	18.3	8.2	10.97	—12.30	.053	.068	.057	.058	.82	.68	.91	.81
10	.877	.978	30.013	.9648	1.7	8.9	2.4	4.63	—18.63	.044	.049	.047	.046	.91	.75	.96	.85
11	.889	.519	29.391	.5840	16.1	28.7	34.9	27.12	+ 3.85	.056	.116	.161	.111	.61	.73	.79	.69
12	.471	.464	.408	.4410	25 1	33.4	29.8	29 63	+ 6.38	.116	.157	.125	.131	.86	.82	.75	.80
13	.318	.257	.203	.2530	28.4	35.2	26.6	33.42	+10.17	.126	.157	.173	.150	.81	.76	.79	.78
14	.059	.519	—	—	33.4	22.6	—	—	—	.171	.096	—	—	.89	.79	—	—
15	.624	.292	.035	.2975	13.6	27.3	30.2	24.98	+ 1.73	.067	.111	.121	.106	.83	.74	.71	.77
16	.016	.122	.366	.1848	21.9	14.3	3.9	12.40	—10.97	.104	.058	.040	.064	.89	.70	.76	.79
17	.531	.703	.918	.7393	—12.1	—1.2	0.6	—4.62	—27.97	.024	.039	.040	.034	.91	.94	.88	.91
18	.978	30.015	30.110	30.0418	—5.9	5 0	—0.1	—0.40	—23.83	.031	.046	.044	.039	.93	.84	.97	.89
19	30.116	29.913	29.728	29.9035	—5.2	12.5	15.8	8.50	—15.03	.031	.067	.065	056	.90	.88	.74	.83
20	29.705	.623	.553	.6262	21.5	28.8	30.6	27.32	+ 3.70	.095	.121	.115	.116	.82	.76	.67	.77
21	.472	.478	—	—	31.6	34.5	—	—	—	.140	.144	—	—	.78	.72	—	—
22	.366	.208	.392	.3223	35.6	40.3	37.4	37.63	+13.82	.178	.201	.196	.189	.85	.80	.87	.83
23	.352	.142	.172	.2150	33.1	43.9	38.1	38.67	+14.73	.167	.200	.179	.182	.88	.70	.77	.78
24	.197	.364	.532	.3785	33.4	38.9	35.3	36.22	+12.03	.163	.152	.164	.161	.85	.63	.80	.76
25	.489	.358	.438	.4375	30.9	33.3	31.6	31.50	+ 7.17	.149	.182	.178	.162	.86	.93	1.00	.91
26	.708	.757	.804	.7650	21.2	26.6	18.3	22.33	— 2.20	.092	.105	.087	.095	.81	.73	.87	.79
27	.837	.669	.470	.6395	13.6	32.0	33.8	27.75	— 3.03	.072	.158	.173	.138	.90	.87	.89	.87
28	.382	.460	—	—	36.5	39.2	—	—	—	.201	.190	—	—	.92	.79	—	—
29	.699	.814	.854	.7950	23.3	26.2	22.6	23.82	— 1.20	.110	.103	.103	.106	.87	.73	.85	.82
30	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
31	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
M	29.4999	29.4623	29.5074	29.4914	20.79	27.40	24.64	24.32	+ 0.65	.110	.126	.123	.119	.86	.78	.81	.82

Day.	Direction of Wind.			Resul't. Direc-tion.	Velocity of Wind.					Rain in inches.	Snow in inches.
	6 A. M.	2 P. M.	10 P. M.	°	6 A.M.	2 P.M.	10 P.M.	Re-sul't.	ME'N		
1	E b N	S W	W S W	S 50 W	15.3	21.0	14.5	12.53	14 81	0.365	..
2	S W b S	S W b S	Calm.	S 71 W	3.0	11.0	0.0	6.98	8.38	...	...
3	W S W	W b N	W S W	S 74 W	6.5	15.5	10.2	10.48	11.78	...	0.2
4	S	S S W	Calm.	S	16.0	10.2	0.0	7.30	8.82	...	1.2
5	S W	W b S	E b N	N 9 W	8.2	0.5	5.0	1.30	4.31	...	0.2
6	N b E	N N W	N W b N	N 26 W	6.6	11.5	7.2	6.64	7.36	...	3.0
7	W	S W b S	S W b S	S 38 W	4.5	16.2	20.0	14 13	14.65	...	0.5
8	W b S	W b N	W b N	N 89 W	9.5	23.8	6.6	13.30	13.36	...	0.1
9	W N W	N W b W	N W b W	N 49 W	4.6	20.0	6.8	7.51	7.91	...	...
10	N N W	N W	N N W	N 47 W	2.0	9.5	1.8	4.04	5.16	...	...
11	S W	S W b S	W S W	S 62 W	12.0	20.0	9.0	11.92	13.63	...	0.1
12	W	W	S W	S 77 W	8.2	16.5	9.5	11.60	12.27	...	...
13	S W b W	S W b S	W S W	S 52 W	13.0	9.0	13.4	9.88	10.01	...	...
14	S W	N W	N b E	N 38 W	5.6	22.5	10.0	13.55	15.63	...	...
15	N E	S E	W S W	N 20 E	7.0	11.2	4.0	0.40	9.57	...	0.5
16	W N W	N W b W	W b N	N 57 W	17.5	24.0	21.5	20.41	21.27		1.2
17	N N W	W N W	W b S	N 70 W	10.0	27.0	9.6	10.83	11.32	...	...
18	W b N	W S W	W S W	S 81 W	4.0	13.6	9.5	9.63	9.74	...	...
19	W b N	S W	S W b W	S 49 W	4.2	19.8	16.0	14.98	15.28	...	0.1
20	S W b W	S S W	S S W	S 28 W	8.2	13.2	12.4	9.02	9.30	...	0 1
21	S S W	S b W	S b W	S 14 W	7.0	5.0	1.0	4.07	4.10	...	...
22	S b W	S	W	S 37 W	4.0	5.2	9.8	5.33	6.67	0.032	...
23	S S W	S S W	S W	S 42 W	3.4	3.0	9.0	5.53	5.86	...	...
24	S W b W	W N W	W b S	N 69 W	5.4	19.4	4.5	8.72	9.48	...	...
25	W N W	E N E	N b W	N 14 E	0.8	12.0	11.6	8.38	10.23	...	2.5
26	N N W	N W	N W	N 35 W	12.2	21.5	2.0	7.56	9.14	...	...
27	N W	S S E	E b S	S 57 E	2.4	6.0	3.8	2.05	2.64	...	Inp.
28	Calm.	W b S	W	S 89 W	0.0	14.0	14.5	12.27	12.99	..	...
29	W b W	W b N	Calm.	N 83 W	12.0	15.5	0.0	7.41	7.50	...	Inp.
30	...	...	...	...	...	...	...	...	...	...	...
31	...	...	...	...	...	...	...	...	...	...	...
M	....	....	....	....	7.35	14.40	8.39	......	10.11	0.397	9.5

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR FEBRUARY, 1864.

NOTE.—The monthly means do not include Sunday observations. The daily means, excepting those that relate to the wind, are derived from six observations daily, namely, at 6 A.M., 8 A.M., 2 P.M., 4 P.M., 10 P.M., and midnight. The means and resultants for the wind are from hourly observations.

Highest Barometer . . . . . . 30.124 at 8 a.m. on 19th. } Monthly range=
Lowest Barometer . . . . 29.009 at mid't. on 15th. } 1.115 inches.

Self-register-ing Ther.
- Maximum temperature . . . . 45°0 on p.m. of 23rd } Monthly range=
- Minimum temperature . . . . —15°0 on a.m. of 17th } 60°0
- Mean maximum temperature . . 31°52 }
- Mean minimum temperature . . 18°94 } Mean daily range=12°58
- Greatest daily range . . . . 37°4 from a. m. to p. m. of 11th.
- Least daily range . . . . 3°3 from a. m. to p. m. of 8th.

Warmest day . . . 23rd...Mean Temperature . . . 38°67 }
Coldest day . . . 17th...Mean Temperature . . . —4°62 } Difference=43°29.

Maximum Radiation { Solar (Vacuum) . . . . 105°6 on p. m of 26th } Monthly range=
{ Terrestrial . . . . —15°8 on a. m. of 17th } 121°.4

Aurora observed on 4 nights, viz.:—on 1st, 8th, 9th, and 10th.
Possible to see Aurora on 11 nights; impossible on 18 nights.
Snowing on 14 days; depth 9 5 inches; duration of fall, 55.6 hours.
Raining on 2 days; depth, 0.397 inches; duration of fall, 7.5 hours.
Mean of cloudiness=0.72; above average, .01. Most cloudy hour observed, 4 p.m.; mean=0.80; least cloudy hour observed, mid't.; mean=0.56.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
1705.92	2141.01	348.10	4844.54

Resultant direction, S. 84° W.; Resultant Velocity, 6.48 miles per hour.
Mean velocity 10.11 miles per hour.
Maximum velocity 37.0 miles, from 10 to 11 a.m. on 14th.
Most windy day 16th—Mean velocity 21.27 miles per hour. }
Least windy day 27th—Mean velocity 2.64 miles per hour. } Difference 18.63.
Most windy hour, 1 to 2 p. m.—Mean velocity, 15.03 miles per hour. } Difference
Least windy hour, 4 to 5 a.m.—Mean velocity, 7.02 miles per hour. } 8.01 miles.

1st to 7th inclusive, very gloomy and mild.—9th, Solar Halo and Parhelia at 5 p.m.—11th, Solar Halo at 10 a.m. and noon, pleasant.—16th to 19th inclusive, very cold and stormy days.—17th, Lunar Halo at 9 p.m.—23rd, Solar Halo noon to 2 p.m. Lunar Halo at 10 p.m.—25th, Fog 6 to 8 a.m. Very gloomy day.—27th, Fog 8 a.m. Very gloomy.

Great range of Temperature.

13th p.m. = 39.°0 }
17th a.m. = —15.°0 } Descending range in 86 hours = 54.°0
23rd p.m. = 45.°0—Ascending range in 150 hours = 60.°0
Movement in 236 consecutive hours = 114.°0

February 1864 was comparatively mild, dry, windy, and cloudy.

COMPARATIVE TABLE FOR FEBRUARY.

YEAR.	TEMPERATURE. Mean.	Excess above Average, (45°5).	Maximum observed.	Minimum observed.	Range.	RAIN. No. of days.	Inches.	SNOW. No. of days.	Inches.	WIND. Resultant. Direction.	Velocity.	Mean Force or Velocity
1840	° 28.0	+ 5.0	° 49.1	° — 8.3	° 57.4	8	1.475	6	...	...	...	...
1841	22.4	— 0.6	43.4	— 0.3	43.7	1	Inap	9	...	...	...	0.61 lbs
1842	26.9	+ 3.9	48.7	+ 2.5	46.2	8	3.625	9	...	...	...	1.03 "
1843	14.5	— 8.5	37.5	—10.2	47.7	1	0.475	21	14.4	...	...	1.05 "
1844	26.0	+ 3.0	47.1	— 0.4	47.5	4	0.430	7	10.0	...	...	0.43 "
1845	26.0	+ 3.0	46.6	— 3.9	50.5	5	Imp	9	19.0	...	...	0.99 "
1846	20.4	— 2.6	41.4	—16.2	57.6	0	0.000	13	46.1	...	...	0.65 "
1847	21.5	— 1.5	42.2	— 1.0	43.2	2	0.550	13	27.3	...	...	0.69 "
1848	26.6	+ 3.6	46.9	— 0.6	47.5	4	0.775	8	10.8	N 65 W	2.53	5.69 ms
1849	19.5	— 3.5	41.1	— 9.2	50.3	2	0.240	13	19.2	N 41 W	1.48	6.58 "
1850	26.0	+ 3.0	49.2	+ 1.3	47.9	7	1.235	9	23.1	N 80 W	3.43	7.61 "
1851	27.6	+ 4.6	50.2	+ 1.3	48.9	7	2.600	4	2.4	N 64 W	1.99	6.94 "
1852	23.4	+ 0.4	41.2	— 3.2	44.4	3	0.650	11	13.0	S 75 W	3.34	6.42 "
1853	24.1	+ 1.1	43.4	— 0.6	44.0	4	1.030	15	12.6	N 49 W	2.51	7.30 "
1854	21.1	— 1.9	42.7	— 5.7	48.4	5	1.460	15	13.0	N 7 E	1.73	6.91 "
1855	15.4	— 7.6	37.3	—25.0	62.3	2	1.770	14	21.8	N 40 W	4.34	8.17 "
1856	15.7	— 7.3	35.3	—18.7	54.0	0	0.000	8	9.7	N 81 W	7.70	10 71 "
1857	28.5	+ 5.5	51.2	— 5.9	57.1	11	3.050	11	11.7	S 78 W	3.68	9.82 "
1858	17.0	— 6.0	40.9	— 6.6	47.5	1	Inap	16	26.7	N 72 W	3.22	9.12 "
1859	26.0	+ 3.0	43.3	+ 3.9	39.4	6	0.455	14	8.3	N 54 W	2.72	8.50 "
1860	22.8	— 0.2	48.1	— 8.4	56.5	7	1.330	13	18.8	N 61 W	3.28	8.73 "
1861	26.1	+ 3.1	44.6	—20.4	65.0	4	0.815	17	29.7	N 77 W	3.86	10.58 "
1862	22.5	— 0.5	35.6	— 3.7	39.3	3	0.180	17	23.1	N 55 W	3.93	8.52 "
1863	22.4	— 0 6	38.9	—19.8	58.7	7	1.450	12	22.0	N 23 W	2.29	10.13 "
1864	24.3	+ 1.3	43.9	—13.0	56.9	2	0.397	14	9.5	S 84 W	6.48	10.11 "
Results to 1864.	22.99	...	43.59	—6.88	50.48	4.2	1.000	11.9	18.05	N 70 W	3.15	8.34
Exc. for 1864.	+1.33	...	+0.31	—6.12	+6.42	— 2.2	— 0.603	+ 2.1	— 8.55	...	...	+1.77

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—MARCH, 1864.

Latitude—43 *deg.* 39.4 *min. North. Longitude*—5 *h.* 17 *min.* 33 *sec. West. Elevation above Lake Ontario,* 108 *feet.*

Day.	Barom. at temp. of 32°. 6 A.M.	2 P.M.	10 P.M.	MEAN.	Temp. of the Air. 6 A.M.	2 P.M.	10 P.M.	ME'N	Excess of mean above Normal.	Tens. of Vapour. 6 A.M.	2 P.M.	10 P.M.	M'N	Humidity of Air. 6 A.M.	2 P.M.	10 P.M.	M'N	Direction of Wind. 6 A.M.	2 P.M.	10 P.M.	Resultant Direction.	Velocity of Wind. 6 A.M.	2 P.M.	10 P.M.	Result.	ME'N	Rain in Inches.	Snow in Inches.
1	29.759	29.561	29.570	29.6217	15.1°	25.9°	23.0°	22.22°	− 3.00°	.074	.107	.106	.100	.86	.76	.86	.84	Calm.	W b S	W b S	S 86° W	0.0	0.5	5.2	3.01	3.18	...	0.2
2	.525	.689	.915	.7287	23.0	26.6	23.7	24.37	− 1.05	.106	.105	.098	.101	.86	.73	.77	.76	W b N	W N W	W	N 65 W	1.5	27.0	8.0	10.73	10.90	...	0.1
3	.937	.850	.624	.8080	17.6	33.4	29.5	27.20	+ 1.48	.088	.140	.144	.129	.92	.78	.87	.85	Calm.	S b E	E b S	S 16 E	0.0	5.6	2.5	2.85	4.43	...	...
4	.409	.222	.186	.2678	31.3	45.4	29.9	39.93	+13.93	.152	.199	.190	.185	.86	.64	.77	.75	S W b W	S W b S	W S W	S 54 W	3.0	10.0	3.2	4.17	5.99	0.305	...
5	.167	.170	.310	.2235	35.3	30.9	29.1	31.65	+ 5.45	.198	.149	.141	.163	.96	.86	.87	.90	N N E	N b E	N W b N	N 16 W	5.8	15.5	8.0	9.78	10.81	0.300	1.0
6	.366	.440	—	—	24.4	34.5	—	—	—	.103	.149	—	—	.78	.74	—	—	W N W	N W	N N W	N 36 W	6.0	7.8	5.0	3.97	4.26	...	...
7	.450	.347	.354	.3803	25.2	40.3	30.6	32.55	+ 5.73	.115	.159	.094	.131	.85	.63	.54	.70	N W b N	N W	N W b W	N 48 W	7.5	18.5	10.0	10.67	10.91	...	...
8	.398	.467	.645	.5137	24.8	39.2	29.1	31.32	+ 4.08	.098	.120	.133	.118	.73	.49	.82	.68	N W b W	S W	N W b N	N 50 W	2.0	0.5	4.5	3.17	3.81	...	...
9	.799	.823	.800	.8100	24.4	37.0	33.4	31.80	+ 4.28	.110	.114	.171	.136	.84	.51	.89	.76	W N W	W N W	S W	N 17 E	4.8	6.0	3.0	2.65	6.80	...	...
10	.630	.374	.201	.3758	32.7	32.4	37.0	34.02	+ 6.20	.157	.161	.219	.178	.85	.87	.99	.90	E b N	E b N	E	N 85 E	18.0	15.6	9.5	12.17	12.23	0.080	...
11	.083	28.852	28.928	28.9543	37.4	41.0	40.7	39.33	+11.10	.223	.247	.224	.226	.99	.95	.87	.93	E b N	N E b E	W b S	S 86 W	7.0	3.5	13.5	4.81	9.62	0.480	...
12	.187	29.370	29.524	29.3793	32.7	36.3	33.4	33.92	+ 5.37	.143	.157	.141	.147	.76	.74	.74	.75	W	W	N W b W	N 86 W	20.5	14.5	7.2	7.84	8.45	...	..
13	.545	.528	—	—	27.7	35.3	—	—	—	.135	.138	—	—	.89	.67	—	—	N	N	N N W	N 17 W	1.0	6.5	14.0	8.24	8.53	..	...
14	.690	.658	.610	.6515	23.3	36.0	33.1	80.85	+ 1.53	.103	.137	.153	.133	.82	.65	.81	.76	N N W	S	S W b S	S 35 W	3.5	4.0	5.5	4.27	5.62	...	Inp.
15	.594	.619	.658	.6218	27.3	25.1	17.2	22.90	− 6.82	.133	.116	.081	.109	.89	.86	.85	.87	W b S	N W b N	N W b N	N 43 W	12.5	13.8	14.5	12.73	13.56	...	0.1
16	.568	.481	.499	.5118	18.6	30.9	26.2	25.85	− 4.18	.090	.134	.110	.116	.89	.77	.77	.82	N W b W	W b N	W S W	N 83 W	10.2	12.4	7.4	7.86	8.23	...	Inp.
17	.435	.293	.224	.3078	27.3	36.0	33.1	31.65	+ 1.20	.126	.153	.160	.147	.84	.73	.85	.82	W b S	S W b S	S W b S	S 30 W	0.5	18.0	18.4	16.29	16.41	...	0.5
18	.009	.009	.308	.1152	33.4	32.4	17.9	27.18	− 3.67	.178	.146	.067	.121	.93	.79	.67	.76	S b W	W	N W b W	S 87 W	21.0	31.8	21.0	16.49	20.68	...	0.4
19	.417	.420	.462	.4292	12.5	20.5	14.0	16.13	−15.13	.068	.061	.068	.071	.88	.55	.83	.79	W b N	W b S	N E b N	N 79 W	6.8	17.6	4.8	7.95	9.06	...	Inp.
20	.461	.516	—	—	6.8	16.8	—	—	—	.051	.061	—	—	.86	.63	—	—	N N W	W b S	W N W	N 65 W	9.5	15.4	6.0	9.57	10.50	...	...
21	.699	.755	.897	.8010	3.9	16.9	13.2	11.92	−20.17	.045	.060	.066	.059	.86	.62	.83	.79	W	W	N N W	N 77 W	5.5	16.6	6.5	8.74	10.58	...	...
22	30.032	30.032	.900	.9862	3.5	16.9	12.9	11.75	−20.73	.044	.053	.057	.049	.87	.56	.73	.66	N b E	E S E	N E b N	N 48 E	4.0	9.2	6.0	4.95	5.95	...	...
23	29.859	29.773	.746	.7902	11.4	29.1	24.1	21.87	−10.92	.062	.104	.074	.080	.86	.65	.55	.67	N b E	N E b N	W S W	N 21 W	4.8	6.0	1.5	1.97	3.27	...	...
24	.765	.716	.619	.7062	17.9	40.3	29.5	30.85	− 2.32	.079	.105	.129	.104	.80	.41	.78	.62	W	S b W	S W	S 35 W	2.5	10.5	3.0	4.76	5.01	...	...
25	.582	.374	—	—	26.6	37.4	—	—	—	.126	.162	—	—	.87	.72	—	—	S W	E N E	Calm.	N 69 E	2.8	9.6	0.0	3.26	3.84	0.010	...
26	.477	.596	.708	.6068	36.0	39.9	31.3	35.62	+ 1.63	.196	.206	.152	.183	.93	.84	.86	.87	Calm.	E	S E b S	S 3 W	0.0	1.6	4.0	0.68	1.80	Inp.	...
27	.764	.776	—	—	29.1	36.3	—	—	—	.155	.193	—	—	.96	.90	—	—	Calm.	W S W	S W b W	N 49 E	0.0	2.5	2.0	1.33	2.66	...	...
28	.800	.676	.533	.6442	31.3	34.5	38.1	35.12	+ 0.40	.163	.173	.187	.175	.94	.86	.81	.85	E N E	E b N	E	N 82 E	8.6	19.5	22.0	17.99	18.03	...	...
29	.393	.364	.339	.3703	37.8	37.8	38.5	37.30	+ 2.20	.183	.183	.225	.195	.80	.80	.96	.87	E b N	E	E b N	N 86 E	16.5	12.4	15.4	14.90	15.07	0.255	1.0
30	.257	.229	.244	.2468	36.0	34.5	33.4	34.70	− 0.80	.154	.145	.178	.162	.74	.72	.93	.81	E	N E b E	N N E	N 60 E	16.5	10.6	6.0	8.77	9.59	0.065	0.2
31	.287	.338	.422	.3577	33.8	37.4	34.5	35.23	− 0.68	.184	.214	.200	.199	.95	.95	1.00	.97	N N E	E N E	Calm.	N 64 E	3.5	1.5	0.0	1.03	1.06	0.125	0.2
M	29.5262	29.4880	29.5099	29.5082	25.13	32.95	28.71	29.12	− 1.26	.126	.141	.137	.135	.86	.72	.82	.80	....	....	....	....	6.64	11.11	7.66	....	8.41	1.620	3.7

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR MARCH, 1864.

NOTE.—The monthly means do not include Sunday observations. The daily means, excepting those that relate to the wind, are derived from six observations daily, namely at 6 A.M., 8 A.M., 2, 4 and 10 P.M., and midnight. The means and resultants for the wind are from hourly observations.

Highest Barometer............................30.067 at 8 a.m. on 22nd } Monthly range =
Lowest Barometer ....28.829 at 4 p. m. on 11th } 1.238 inches.

Self-regist'ing Thermom.
Maximum Temperature ....50°2 on p.m. of 4th } Monthly range =
Minimum Temperature .... 3°0 on a.m. of 21st & 22d } 47°2
Mean maximum Temperature .... 35°59 } Mean daily range =
Mean minimum Temperature .... 22°44 } 13°16
Greatest daily range ......28°4 from a.m. to p.m. of 24th.
Least daily range............ 3°3 from a.m. to p.m. of 15th.

Warmest day .... 4th .. Mean temperature.......... 39°93 } Difference = 28°18.
Coldest day .... 22nd... Mean temperature......... 11°75 }
Maximum { Solar................................ 100°0 on p.m. of 7th } Monthly range =
Radiation. { Terrestrial....................... —4°0 on a.m. of 21st } 104°0
Aurora observed on 2 night, viz.,—on 6th and 7th.
Possible to see Aurora on 15 nights; impossible on 16 nights.
Snowing on 12 days, depth 3.7 inches; duration of fall, 35.6 hours.
Raining on 9 days, depth 1.620 inches; duration of fall 60.1 hours.
Mean of cloudiness = 0.66; above average 0.06.
Most cloudy hour observed, 4 p.m; mean = 0.75; least cloudy hour observed, 6 a.m.; mean, = 0.59.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
1972.27	938.08	1731.97	3081.23

Resultant direction N. 53° W.; Resultant velocity 2.29 miles per hour.
Mean velocity ....8.41 miles per hour.
Maximum velocity .... 31.8 miles, from 2 to 3 p.m. on 18th.
Most windy day ......18th............Mean velocity, 20.68 miles per hour. } Difference =
Least windy day ...31st..............Mean velocity, 1.06 ditto. } 19.62 miles.
Most windy hour .... 2 to 3 p.m..................Mean velocity, 11.35 ditto. } Difference =
Least windy hour ...4 a.m. to 5 a.m..........Mean velocity 6.52 ditto. } 4.83 miles.

4th. Solar halo at 4 p.m.; mild day.—6th. Solar halo and parhelia from 10 a.m. to 2 p.m.—7th. Faint auroral light from 7 p.m. to midnight.—9th. Solar halo and parhelia 1 to 2 p.m.—18th. Stormy day; wind very high and in violent squalls.—22nd. Lunar halo at 10 p.m. and midnight.—26th. Fog at 2 p.m.; mild.—27th. Dense fog nearly all day.—28th. Fog at 6 and 8 a.m.; sheet lightning in S.W. at 8 and 9 p.m. (first of the season).—31st. Fog at 10 p.m.; slight rain to 3.30 p.m.; snow from 11 p.m. to 2 am. of 1st April.

March, 1864, was comparatively cold, calm, and cloudy; it had more rain and less snow than the average, and with regard to total precipitation may be recorded as a dry month.

COMPARATIVE TABLE FOR MARCH.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above aver'ge (26.1)	Max. ob-served.	Min. ob-served.	Range.	No. of days.	Inches	No. of days.	Inches	Resultant. Direction.	Resultant. V'y.	Mean Force or Velocity.
1840	° 35.3	° + 3.4	° 56.9	° 8.7	° 48.2	8	1.640	8	...	...	...	....
1841	27.7	— 2.2	53.5	— 6.9	60.4	5	1.170	7	...	...	...	0.51lbs.
1842	35.8	+ 5.9	68.7	14.9	53.8	4	3.150	8	...	...	...	0.70
1843	21.3	— 8.0	38.6	— 2.8	41.4	2	0.625	18	25.7	...	...	1.18
1844	31.3	+ 1.4	50.3	9.6	40.7	8	2.470	8	14.0	...	...	0.57
1845	35.4	+ 5.5	61.7	9.9	51.8	5	Imp.	8	2.8	...	...	0.66
1846	33.1	+ 3.2	49.3	7.6	41.7	9	1.965	5	2.3	...	...	0.30
1847	26.2	— 3.7	44.3	4.8	39.5	5	0.850	6	4.2	...	...	0.71
1848	28.6	— 1.3	58.9	0.9	58.0	5	1.220	6	9.7	N 66° W	2.03	5.80mls.
1849	33.5	+ 3.6	53.4	15.4	38.0	7	1.525	2	2 3	N 3° W	1.48	5.37
1850	29.8	— 0.1	46.0	6.0	40.0	2	0.745	7	11 2	N 52° W	2.62	7.62
1851	32.4	+ 2.5	58.7	13.1	45.6	3	0.770	9	8.8	N 21° W	1.93	7.65
1852	27.7	— 2.2	44.8	— 3.2	48.0	8	3.080	12	19.5	N 8° W	0.71	5.81
1853	30.6	+ 0.7	56.3	— 0.1	56 4	6	1.030	8	7.1	N 58° W	2.60	5.93
1854	30.7	+ 0.8	52.8	10.4	42.4	9	2.425	3	2.8	N 53° W	3.39	8.03
1855	23.5	— 1.4	48.6	— 2.9	51.5	5	1.485	11	18.1	N 88° W	4.76	9.95
1856	23.1	— 6.8	39.3	—13 6	52.9	0	0.000	12	16.2	N 71° W	7.68	11.39
1857	27.8	— 2.1	56.5	— 3.9	60.4	4	0.335	15	11.3	N 63° W	6.63	10 84
1858	28.4	— 1.5	54.1	— 5.5	59.6	10	0.917	6	0.2	N 58° W	5.45	8.56
1859	36.3	+ 6.4	53.7	10.4	43.3	15	4.054	8	1.0	N 64° W	1.96	10.39
1860	34.5	+ 4.6	66.4	14.2	52.2	5	0.882	11	2.4	N 64° W	7.61	12.41
1861	26.9	— 3.0	43.2	— 4.1	47.3	8	2.125	14	7.1	N 54° W	4.33	10.56
1862	28.8	— 1.1	41.4	9.3	32.1	8	2.560	11	18.5	N 12° W	2.50	9.38
1863	25.8	— 4.1	41.4	— 3.4	44.8	4	0.687	17	11.4	N 27° W	2.62	9.27
1864	29.1	— 0.8	45.7	3.5	42.2	9	1.620	12	3.7	N 53° W	2.29	8.41
Results to 1864.	29.86	...	31.38	3.69	47.69	6.2	1.557	9.3	9.10	N 57° W	3.35	8.67
Exc. for 1864.	— 0.74	...	— 5.68	— 0.19	— 5.47	+ 2.8	+ 0.063	+ 2.7	— 5.40	....	... ..	— 0.26

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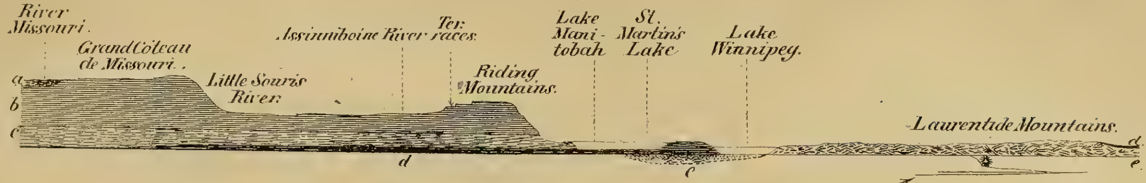
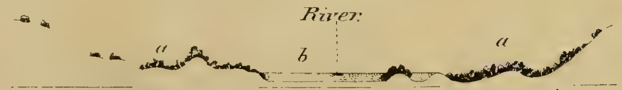
☞ MR. EDWARD ALLEN, 12, Tavistock Road, Covent Garden, London, W , has been appointed the English Agent for the Institute. All European communications are requested to be forwarded through him.

Profile of country from Lake Winnipeg to the Grand Côteau de Missouri.



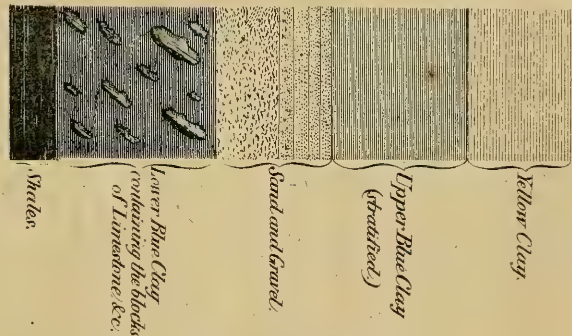
a. Tertiary.
b Cretaceous.
c. Devonian.
d. Silurian.
e. Laurentian
* Niagara escarpment, 600 to 1400 ft above the sea-level.

Section of the Valley of the East Branch of the Moisie, — in the Burnt Country (3 miles.)

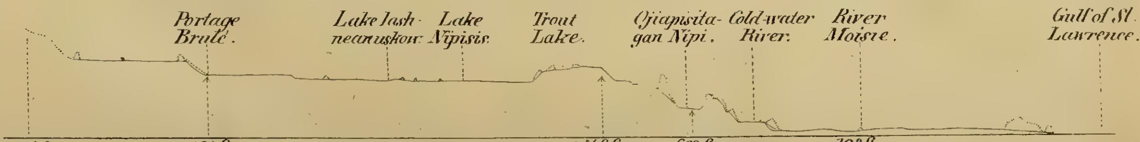


a. Boulders of Gneiss and Labradorite.
b. Coarse sand.

Section showing the forced arrangement of Blocks of Limestone &c. in Boulder-Clay.



Section of the Canoe-route from the Portage Brulé to the Gulf of St. Lawrence.



Vertical scale five times the horizontal.

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THE CANADIAN JOURNAL.

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NOTES ON LATIN INSCRIPTIONS FOUND IN BRITAIN.

PART X.

BY THE REV. JOHN McCAUL, LL.D.,

PRESIDENT OF UNIVERSITY COLLEGE, TORONTO, AND OF THE CANADIAN INSTITUTE.

In compliance with suggestions that it would be advantageous to resume the papers on "Latin Inscriptions found in Britain," I purpose continuing the series occasionally as time permits. My last article on this branch of Epigraphy appeared in the *Canadian Journal* for January, 1862, when I ceased contributing articles on the subject, as I was engaged in preparing for the Press the volume on "Britanno-Roman Inscriptions," in which all my published notes were collected, with the addition of others that had not appeared in print. In this and succeeding Parts, I shall not only use some materials that I then laid aside from a desire to limit the bulk of the book, but shall also give the results of subsequent investigation.

58. Horsley's n. cix. Northumberland, is an inscription found at Hexham. It stands thus in his copy:

IMP·CAES·L·SEP
PERTINAX ET IMP·C
AVRANTONIN
VSII
HORI
VEXILLATION
FE RVNT

The following is his expansion:

Imperator Cæsar Lucius Septimius Pertinax et Imperator Cæsar Marcus *Aurelius Antoninus pius* felix Augustus et Geta Cæsar *cohortium vexillationes fecerunt.*

Dr. Bruce, *Roman Wall*, p. 315, 2nd ed., figures the slab and offers the suggestion:

"If the word in the fifth line be intended for *horreum*, which it probably is, the stone records the building of a granary by a vexillation of some portion of the Roman forces."

In the "*Wallet-book of the Roman Wall*," 1863, he strangely rejects this reading, and remarks:

"The third and fourth lines of the inscription probably stood thus:—

. . ET IMP·P·SEP·
GETA COHORTES.

Certain cohorts and vexillations seem to have been employed upon some work at this time; what, does not appear."

I much prefer *horreum*, but would read the last three words—*horreum vexillationi fecerunt; i.e.* The Emperors made the granary for the vexillation stationed at Hexham or in its neighbourhood.

On another slab, found at Great Chesters, *Æsica*, we have a record of the rebuilding of a granary in 225 A.D. See *Brit. Rom. Inscrip.* pp. 154—156. It is strange that so few commemorative tablets of this class have been found in the island, for there must have been many such buildings.

59. In the *Archæologia Æliana*, new series, i. p. 250, we have a fragment of an inscription from Carvoran, *Magna*:—

IVSAGRI
AMIORV

Dr. Bruce remarks:

"The name of Calpurnius Agricola occurs upon two or three inscriptions in connection with the Hamii at *Magna*. There can be no doubt that we have before us fragments of the words—

CALPVRNIVS AGRICOLA
HAMIORVM.

The date of these inscriptions is unknown."

Every scrap of information relative to this cohort of Hamians is interesting and valuable, for the only notice that has been discovered of it, so far, is in inscriptions found in Britain. Mr. Roach

Smith, *Collectanea Antiqua*, vi. p. 39, identifies it with the *cohors prima Apamenorum* of the *Notitia;* but there is no ground for this identification, and Mr. S. seems to have strangely confused the towns *Apamea* and *Hamah*, from which latter, as Mr. Hodgson first suggested, the *cohors prima Hamiorum* probably derived its name. Dr. Bruce's reading of the few letters on the broken stone is both acute and satisfactory, but I cannot understand his remark—"The date of these inscriptions is unknown."

From an inscription, given in the same page in the *Arch. Æliana*, we may infer that this cohort was at *Magna* in 136 or 137 A.D., for Ælius Verus was not Cæsar until the first of these years, and he died on the 1st of January, 138. An inscription, found at Kilsyth, Scotland, suggests that this cohort was stationed there, perhaps during the construction of the northern barrier about 140, from which they seem to have been recalled and stationed again at *Magna*, in the reign of M. Aurelius Antoninus (*i.e.* 162—180), under whom Calpurnius Agricola was legate in Britain.

We have, I think, another memorial of their stay at *Magna*, in an altar, figured by Dr. Bruce, *Roman Wall*, p. 399, 2nd Ed. It was erected (as I read it) by *Julius Pastor Imag*[inifer] of the cohort of Hamians.

In the *Notitia*, the second cohort of Dalmatians is mentioned as stationed at *Magna*, but no traces* of this cohort have been found there.

60. One of the most perplexing inscriptions, found in Britain, is on a small altar, discovered in York, in 1752, and at present in the Museum of the Philosophical Society of that city. It may be represented thus :†

MAT·A ? ? IA· ? A
M ? I ? ? ? ? DE
MIL·LEG·VI VIC
GVBER·LEG·VI
V·S·L·M.

* A monumental slab, found there and now preserved in the Museum of the Society of Antiquaries, Newcastle-upon-Tyne, may, possibly, be a memorial of this cohort, although it is not named on it. The inscription is by a centurion to his wife, whose birth-place is stated as Salona, the city in Dalmatia. See *Archæol. Æliana*, new series, i. p. 256.

† The queried letters are not effaced, but only doubtful, some of them in a less degree than others. Thus in the first line, the third queried letter is certainly G or C; and in the second, the first five letters are most probably M·MINV.

The various explanations, that had been proposed up to 1842, were collected by Mr. Wellbeloved in his *Eboracum,* and are given in my "Britanno-Roman Inscriptions" in an extract from that work. To these I there added Mr. Kenrick's recent interpretation of GVBER as *Gubernator,* scil. pilot or steersman, "having charge of the vessels, by means of which the legion communicated with places on the Ouse, or the rivers that fall into it." The only suggestions, which I offered, were—the reading of the first line, as MAT·AFLIA·GAV, *i.e. Matribus Afliabus Gavadiis,* (see Henzen, nn. 5929, 5937), and the reading of the second line, as M·MINV·NANDE, instead of M·MINV·MVDE or M·MINV·ANDE, which had been proposed by others—with the remark that I regarded Mr. Kenrick's explanation of GUBER· as more satisfactory than any of which I was aware. I indicated, however, that I was not satisfied that the correct reading had been found. I have therefore occasionally made other attempts, and now submit the result of these efforts as more satisfactory than the explanations that have hitherto been proposed. As to the first line, I adhere to the reading which I suggested, MAT·AFLIA·GAV, as the most probable of which I am aware; although it has since occurred to me that the last letters may have been CA or CAM· for *Campestribus.* The second line I would read also as before—M·MINV·NANDE, but instead of taking *Nande* for the name of a place, I would separate the letters thus, NAN·DE. GVBER seems to me to be used in the same sense, as it is found in the *Fasti Antiatini,* ed. Henzen, n. 6445, on which* that able Epigraphist remarks: [GVBER·] "*Ita scriptum pro* gibber, *qui ut* pumilio (n. 5411,) *in familiis nobilium colebatur, ut ludicro ejus spectaculo delectaretur.*" My view then is that this altar was erected by the hunchback dwarf of the sixth legion, called by the soldiers in fun, from his size, *Minutius*† *Nanus*;‡ and hence we may explain the unusual

* Mommsen, however, takes GVBER in that passage for *gubernator,* for which, he observes, it is often placed.

† Similar applications of names were not uncommon amongst the Romans. It is well known that some of the *cognomina* were derived from personal characteristics, and we are not without examples of *nomina* given in jest, *e. gr. Censorinus,* as we learn from Trebellius *Pollio, Triginta Tyranni,* was called *Claudius,* with reference to his lameness, *Scurrarum joco.*

‡ The practice of having *pumiliones* or *nani* may be illustrated from Suetonius, *Tiberius,* c. 61:—*Interrogatum eum subito et clare a quodam* nano, *adstante mensæ inter copreas;* Juvenal, viii. 32 Nanum *cujusdam Atlanta vocamus;* and Lampridius, *Alexander Severus,* 34.—Nanos et Nanas, *et moriones populo donavit.* In addition to these, already cited by Facciolati, see Pliny, vii. 16; Suetonius, *Augustus,* 43; Propertius, iv. 8, 41; and compare Xiphilinus, lxvii. 8; Horace, *Sat.* ii. 3, 308; and Statius, *Silv.* i. 6, 57.

It may be that NAN was used in jest, as if it were the abbreviation of a tribe, *i.e., Marcus Minutius Nania* tribu.

smallness of the altar, not more than "10 inches high, and 5 inches square." The only point, which remains to be noticed, is DE in the first line. It may be the preposition, *i.e. de militibus legionis sextæ victricis,* used purposely to avoid calling him a *miles;* or it may stand for *delicium, delicia,* or *deliciæ,* "the pet," MIL·, of course, if this be adopted, standing for *militum.*

61. In Dr. Bruce's *Roman Wall,* p. 209, 2nd Ed., a stone, bearing the following fragment of an inscription, is figured:—

ESTRAIA
RIANO
EG$\overline{\text{II}}$

Dr. B. remarks:—

"The Milking Gap slab, to which it has a very close resemblance, enables us to supply the parts that are wanting. The only difference seems to be, that the emperor's name is in the dative case instead of the genitive as in the other example.

[IMP CA]ES TRAIA[NO]
[HAD]RIANO [AVG PP]
[L]EG $\overline{\text{II}}$ [AVG]
[A PLATORIO NEPOTE LEG PR PR]."

This restoration is justified by "the Milking Gab" slab, except in one point, and that an important one, *viz.,* the addition of the letters PP, which do not appear on that slab. This title, *Pater Patriæ,* cannot be introduced *ad libitum;* its presence or absence as a designation of Hadrian may make a difference of eleven years in the date, for it was not assumed by that emperor until 128 A.D. The two* slabs, given by Dr. Bruce, in pp. 202, 203, indicate a period between 117 and 128 A.D., about 124, in which year, as we know from the diploma found at Stannington, Aulus Platorius Nepos was Legate in Britain. The inscriptions, found at Great Chesters, *Æsica,* and Moresby, *Morbium?,* which have the addition of P·P· give a date between 128 and 138 A.D.

The Leicester mile-stone marks the year between August 11, 120, and August 11, 121, within which time Hadrian was probably in the island. The altar already noticed in 59, mentioning *L. Ælius Cæsar,* gives either 136 or 137 A.D.; and Horsley's, n. lxi. *Cumber-*

---

* I suspect that some pairs of slabs, bearing the same inscription, were set up to mark the beginning and the end of work done on the Southern barrier as there were on the Northern. See *Brit. Rom. Inscrip.* p. 235.

land, in which *M. Mænius Agrippa* is named, may be referred to a year between 120 or 121 A.D. and 138 A.D., probably at the beginning of this period. See *Monum. Hist. Brit.* nn. 11, 92.

62. In Mr. Lee's *Isca Silurum,* and "Delineation of Roman Antiquities found at Caerleon," a slab is figured, which bears the following inscription:—

IMPP·VALERIANVS ET GALLIENVS
AVGG·ET VALERIANVS NOBILISSIMVS
CAES·COHORTI VII·CENTVRIAS·A SO
LO RESTITVERVNT·PER·DESTICIVM IVBAM
VC·LEGATVM AVGG·PR PR·ET
VITVLASIVM LAETINIANVM LEG·LEG
II·AVG·CVRANTE·DOMIT·POTENTINO
PRAEF·LEG·EIVSDEM

As the interpretation is fully discussed in my "Britanno-Roman Inscriptions," it is not my intention to take up this part of the subject again. There is a question, however, relative to the date, that I now desire to examine. In a review of Mr. Lee's *Isca Silurum,* in the *Gentleman's Magazine,* for August, 1862, the author remarked:

"As this [restoration] took place in the reign of Valerian and Gallienus, when Valerian, the son of Gallienus, was Cæsar, the date of the inscription must be between A.D. 253 and A.D. 259, just before the revolt of Postumus in Gaul, when the young Cæsar was murdered."

In *Brit. Rom. Inscrip.*, p. 125, I rejected these statements as erroneous, observing: "Gallienus was not associated in the empire until A.D. 254, nor was his son Saloninus, the 'young Cæsar,' killed until A.D. 260;" and I appended the note, with the object of doing justice to a previous enquirer,—"Mr. Newton, *Monum. Hist. Brit.*, gives the correct dates." The same critic, in reviewing my book in the *Gentleman's Magazine,* for April, 1863, notices my observation in the following terms:

"We are quite willing to rest upon the dates we have given, which are usually accepted; and refer Dr. McCaul to the elaborate paper on the family of the Emperor Valerian in the Baron Marchants' *Lettres sur le Numismatique et l'Histoire.*"

To this the note is appended:

"Paris, 1851. 'Comme il est positif que Salonin est mort in 259,' &c., p. 440. A.D. 253, is even more generally admitted as the year in which Valerian admitted Gallienus as his imperial associate."

The dates, given by the Reviewer, were, I believe, those "usually accepted," and are still received by some. Under ordinary circumstances, then, I should not have impugned their accuracy, but the object of my book being to correct received opinions, if they seemed to me to be unsatisfactory, I felt bound to notice them as in my judgment erroneous, especially as they seemed to be advanced as an emendation of those previously given in the *Monumenta Historica Britannica.*

I shall now give the grounds of my opinion. The question is whether the date of the inscription, as given above, is 253–259 A.D. or 254–260 A.D. The former is selected by the Reviewer, the latter by me. My reason for adopting 260 instead of 259 is, that it appears from mention of the name of the Cæsar Valerian (*i.e.* Saloninus) in the Code of Justinian, iv. 6, 4; v. 42, 2; and x. 16, 2, that he was alive when the first two of those laws were given, *scil.* on the 27th of April and the 15th of May, in the consulship of *Sæcularis* ii. and *Donatus, i.e.* 260 A.D. It is true that he is not mentioned in all the laws of this year, but neither is he in all of the preceding years, when he was unquestionably alive. As to the choice between 253 and 254, I preferred the latter, on the authority of Aurelius Victor, *de Cæsaribus*, c. 32; *Licinio Valeriano imperium deferunt.* * * *Ejus filium Gallienum Senatus Cæsarem creat, statimque Tiberis adulta æstate diluvii facie inundavit.* What summer is that mentioned here? Certainly not of a year before the death of the *Galli.** Now we have unquestionable evidence that they were not slain until their fourth tribunician year, and, as their first year cannot have commenced before the death of Decius, who was killed in 251, their death and the recognition of Gallienus by the senate cannot have taken place before 254. I do not question the assertion that Valerian assumed the imperial title and made Gallienus

* As much confusion exists relative to this period of history, I subjoin an extract of the principal events of the years 251, 252, 253, and 254, that I drew up for my own use after a careful examination of all the ancient and the chief modern authorities.

251. Death of Decius in November. Accession of Gallus and Hostilianus, with Volusianus as Cæsar.

252. Death of Hostilianus in the autumn or winter, after the beginning of the pestilence.

253. Assumption of the Imperial power by Æmilianus in the summer, about the end of July. Valerian proclaimed Augustus by the army in the winter, about the time of the entrance of Æmilianus into Italy.

254. Deaths of the Galli (*scil.* Trebonianus and Volusianus) at Interamnæ, in February, and accession of Æmilianus. Death of Æmilianus in May, and recognition of Gallienus by the senate, in June. Valerian and Gallienus are substituted as Consuls for those who commenced the year.

his colleague in 253, but I think that this tablet, bearing, as it does, the name of an imperial legate of the *Augusti*, was not erected before the death of the *Galli*, and the recognition by the senate. But the Reviewer gives a modern authority in support of his view, the Baron Marchant. On the other side, I may be permitted to refer to Fynes Clinton, whose opinion on such subjects is justly held in the highest estimation. That learned investigator, in his *Fasti Romani*, A.D. 254, remarks:

"Gallienus is associated in the empire." "The son of Valerian [*i.e.* Gallienus] was acknowledged by the senate in June, A.D. 254."

In A.D. 260, he gives the following notes:

"Saloninus slain." "Saloninus was still living, August 29, A.D. 259, and is mentioned in *Cod. Justin.* at May 15, A.D. 260; see col. 3. His death may therefore be placed about June, A.D. 260."

The notices in the Justinian Code are the same which I have already mentioned. Clinton adds the remark: "The Cæsar Valerian is named in only three out of seventeen laws [of the year 260]. If he is rightly inserted, he was still living in May, 260." Here, it must be admitted, is the expression of a doubt as to the correctness of the insertion of the name in this year, but the author's estimation of the value of this doubt is manifest from his disregarding it, and placing the death of Saloninus, and giving the authorities, in 260.

In the 'Chronological Tables of Roman History,' subjoined to Dr. Smith's *Dictionary of Greek and Roman Biography and Mythology*, we have the following notices on the subject:—

"254. Valerianus emperor. His son Gallienus is made Augustus.
"260. Saloninus, the son of Valerian, put to death by Postumus."

The statement that "Gallienus was made Augustus" is correct, for he was in this year not only *Cæsar* but *Augustus*: but "Valerian," in the words "son of Valerian," is a mistake for "Gallienus."

63. In the Museum of the Society of Antiquaries, Newcastle-upon-Tyne, there is a "fragment of a rudely carved monumental stone," from Risingham, which bears an inscriptiou of more than ordinary interest, if my view of it be correct. It is figured in the *Archæologia Æliana*, new series, i. p. 257; and "the letters which appeared [to Dr. Bruce] most probable when the stone was placed under a strong light, are:

SDECEF
ANNXXII
FALIVN
REHITIA
TTCOSC
F
VPFIVVICT
VINCVLV"

When I first saw the copy of this inscription, it at once occurred to me that it was the memorial of a Christian. The notice of the day of the month—KAL·IVN, *i.e. Kalendis Juniis*—(for thus I read the third line)—and the indication of the year by the consul or consuls—characteristics so common in Christian, but so rare in Pagan epitaphs, produced the impression that this inscription was a record of Christianity in Britain during the Roman occupation of the island. There are also other peculiarities in it that appear to me to confirm my view, bnt I am reluctant to venture on conjectures, where the reading is so uncertain, and must defer further statement of my opinion until I have more accurate information relative to those letters that are still legible.

64. In the *Archæologia Æliana*, iii. Pl. i. p. 153, an altar, found at Risingham, is figured. It bears the inscription—

FORTVNAE·REDVC
IVLIVS·SEVERINUS
TRIB EXPLICITO
BALINEO·V S L M

i.e. Fortunæ reduci Julius Severinus Tribunus explicito balineo votum solvit libens merito. In the *Archæologia Æliana,* new series, i. p. 258, Dr. Bruce translates it thus:—

"To Fortune the Restorer, Julius Severinus the Tribune, the Bath being opened, erected this altar in discharge of a vow freely and deservedly made."

Explicito does not mean "opened," but "finished." Thus Scævola, *Digest.* xxxiv. 1, 17, *eo tempore, quo templum* explicitum *fuerit:* and Orelli, n. 3817, explicito *quod promiserat.*

DESCRIPTIVE CATALOGUE OF COINS, ANCIENT AND MODERN, IN THE COLLECTION OF THE CANADIAN INSTITUTE.

(*Continued from No.* L. *page* 105.)

BY THE REV. DR. SCADDING,
LIBRARIAN TO THE INSTITUTE.

No. 2.

GREEK COINS.—(*Continued.*)

II. COPPER.

(A) OF AUTONOMOUS CITIES.

1. Abydos. Obv. Head wreathed to r. Rev. Eagle* Leg. ABY.† Weight—1½ dwts.

2. Abydos. Obv. Head. Rev. Amphora. Leg. AB (reversed.)‡ Weight—5 dwts.

3. Aegium.§ Obv. Head of Pallas to r. Rev. Victory with wreath. In the field a Tortoise,|| and monogram AI repeated in reverse order. Weight—8½ dwts.

4. Ætnaea.¶ Obv. Head of Ceres to r. Rev. Cornu copiae.** Leg. AITNAIΩN. Weight—2 dwts.

5. Apamea on the Orontes.†† Obv. Head of Jove laureated, to l. Rev. A fulmen. Leg. AΠ. in a wreath of wheat-ears. Weight—3 dwts.

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* "Aquilæ causa incerta."—Eckhel ii. 478.

† "Qua per angustas vectae male virginis undas
Seston Abydena separat urbe fretum."—Trist. i. x. 28.

‡ This coin is very much worn. The AB may denote the *Aburia gens.*

§ "Achaiae nobilissima urbs quo non Achaei solum, sed universi Peloponnesii conveniebant, publicis de rebus consultaturi."—Rasche i. 113.

|| "Testudo reptat in numis Aegiorum, qui numi sunt antiquissimi."—Rasche ix. 973.

¶ "Stadiis lxxx. a Catana dissita."—*Vide* Strabo. vi. c. ii. 3.

** "Aetnae montis cineres regionem vicinam reddebant feracem."—Rasch i. 246.

†† Seleucus Nicator so named this place (previously called "Pella" by the Syro-Macedonians) after his wife Apamé, and built there a magnificent Temple to Jove, professing to be descended from him, B.C. 291.

6. Assus in Mysia. Obv. Head of Pallas helmeted, to r. Rev. A gryphon seated;* below, a tortoise. Leg. ΑΣΣ. Weight—5 dwts.

7. Athens. Obv. Head of Athené helmeted, to r. Rev. Warrior hurling a dart. Leg. ΑΘΕ.† Weight—3 dwts.

8. Athens. Obv. Head of Athené helmeted, to r. Rev. Warrior hurling a dart. Leg. ΑΘΕ. [Here the E stands between the A and the Θ.] Weight—6 dwts.

9. Brutii.‡ Gr. Brettii. Obv. Head of Mars bearded and helmeted, to l. Rev. Pallas striding to r, holding a shield before her with both hands; a spear resting against the left shoulder; below the shield a tripod. Leg. ΒΡΕΤΤΙΩΝ. Weight—8 dwts.

10. Cales in Campania. Obv. Head of Pallas helmeted, to l. Rev. A cock crested and spurred;§ behind, a star. Leg. ΚΑΛΕΝΩΝ. Weight 4½ dwts.

11. Centoripa in Sicily.|| Obv. Head of Ceres, to r. Rev. A plough and bird.¶ In the field, one globule. Leg. ΚΕΝΤΟ. Weight—1½ dwts.

12. Cephaloedium in Sicily.** Obv. Head of Hercules bearded,

* "The Greek griffin is curiously like the Persepolitan, and both are apparently derived from the winged lion of the Assyrians, which was the emblem of the god *Nergal*, or Mars."—*Note in Rawlinson's Herodotus*, iii. 23. The story of the "gold-guarding griffins" (*vide* Herod., *loc. cit.*), arose from the jealous care of the natives of the Siberian gold-regions, to prevent the intrusion of strangers.

† "In antiquissimis Atheniensium numis ΑΘΕ, pro ΑΘΗ, seu ΑΘΗΝΑΙΩΝ, atque ΘΕΒΗ pro ΘΗΒΗ, et in monetis Cretensis urbis Phaesti ΘΕΣΕΥΣ pro ΘΗΣΕΥΣ invenimus."—Rasche, iii. 495.

‡ "Populus in extremo Italiae angulo multas et præclaras urbes complexus, quae ingente numero et rara elegantia numos dedere."—Eckhel, i. 166.

§ "Rationem sociati cum Pallade galli adfert Pausanias. Nam cum videret, gallum Minervae cassidi in ejus simulacro insidere, istud factum adfirmat, quod haec avis omnium est pugnacissima."—Eckhel, i. 101.

|| Centoripa (neut. plur.) and Centuripae. Κεντουρίπαι *Ptol.* Quantity not given by Gesner in his Onomasticon; nor by Drisler, in his Ed. of Liddell and Scott. The modern name is Centorbe.

¶ "Cicero describes the Centuripini as *summi aratores*, and as farming largely in every part of Sicily."—Leake, *Numismata Hellenica, sub nom.*

** Cephaloedium is said to be derived from *cephalus*, the thunny-fish, an article of commerce in the Mediterranean. In the lines—

"Quaeque procelloso Cephaloedias ora profundo
Caeruleis horret campis pascentia cete,"

from Silius Italicus (xiv. 252), "horret" graphically describes a vast shoal of

to r. Rev. Small human figure, club and quiver. Leg. ΚΕΦ. Weight—4 dwts.

13. Chalcis* in Euboea. Obv. Female head laureated, to r. Rev. An eagle with a kid in its talons. Weight—4 dwts.

14. Gela† in Sicily. Obv. A youthful head filleted, to r. Rev. A bull butting, to l. In exergue, three globules.‡ Weight—2 dwts.

15. Leucas in Acarnania. Obv. Head of Hercules, to r. Rev. An armed rostrum. In field .... Leg. .... Weight—3 dwts.

16. Messana. Obv. Head of Apollo laureated, to r. Rev Warrior with spear and shield, seated on rocks. Leg. ΜΑΜΕΡΤΙΝΩΝ.§ Weight—6½ dwts.

17. Messana.|| Obv. Veiled head, to l. Rev. Delphic tripod. Leg. ΜΕΣ. Weight—2½ dwts.

18. Pergamus in Mysia. Obv. A youthful head laureated, to r. Rev. In field ΕΡΥΦΙΛΩ ΗΡΟ ΤΟΥ .... ΠΕΡ.¶ Weight—1 dwt.

19. Rhegium. Obv. Head of Proserpine, to r. Rev. A lyre. Leg. in two lines: ΡΗΓΙΝΩΝ. A ligature of ΡΗΓ. Weight—4½ dwts.

20. Rhegium. Obv. Head of Proserpine, to r. Rev. A warrior with spear in left hand; in the r, an eagle or dove. Leg. ΡΗΓΙΝΩΝ. Weight—4¼ dwts.

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this fish as seen from an eminence on the Sicilian coast. The modern name of Cephaloedium is Cefalu.

* Situate where the bridge crossed the Euripus; now *Negroponte*, whence the whole island has its name.

† "Gela inter primores Siciliae urbes veteres fuit celeberrima."—Rasche, iii. 1338. *Terra Nuova* now stands on its site.

‡ "Globuli tres in numis Romanorum aereis quartam assis partem denotant, tres uncias valere quadrantem. Tria puncta seu globuli in Sicula moneta per aream obvii, pretium itidem vel pondus arguunt."—See Rasche, iii. 1459.

§ Messana was occupied in B.C. 270 by Mamertines, *i.e.* Mercenaries, discharged from the service of Syracuse.

|| Anciently *Dancle* and *Zancle*. In the 5th century B C., taken by emigrants from Messenia in Pelopounesus, and named the "City of the Messenii."

¶ On a coin described by Rasche (iii. 821), the orthography of the legend is different. It there reads, ΕΥΡΥΠΥΛΟΣ ΗΡΩΣ. This Eurypylus was the son of Telaphus, the founder of a colony at Pergamus. "Pausanias à Telepho ex Arcadia deductam Pergamum coloniam tradit; in cujus originis memoriam primi conditoris sui filius, Eurypylus, Telephi filius, seu Telephides, olim circa Pergamenum agrum dynasta, publico aere a Pergamenis signatus est."—Rasche, iii. 821.

21. Rhegium. Obv. Two heads to r. jugate.* Rev. A warrior leaning on a staff in left hand; in the r. a palm branch: on the arm a dove or eagle. In field IIII. Leg. ΡΗΓΙΝΩΝ. Weight—$1\frac{1}{2}$ dwts.

22. Syracuse. Obv. Pallas helmeted, to l. Leg. ΣΥΡΑ. Rev. Two dolphins round a star. Weight $20\frac{1}{2}$ dwts.

23. Syracuse. Obv. Head laureated, to l. Leg. .... Rev. A fulmen. Leg. ΣΥΡΑΚΟΣΙΩΝ. Weight—$4\frac{1}{2}$ dwts.

24. Syracuse. Obv. Head bearded and filleted, to r. Rev. A tripod with serpents below. Leg. ΣΥΡΑΚΟΣΙΩΝ. Weight—3 dwts.

25. Syracuse. Obv. Head of Pallas helmeted, to l. Leg. ΣΥΡΑΚ .... Rev. A winged sea-horse.

26. Siculo-Punic. Obv. Head to r.; the hair and beard crisped. In the field a caduceus. Rev. An augur's cap within a wreath. Weight—$4\frac{1}{2}$ dwts.

27. Tauromenium in Sicily. Obv. Head of Apollo Archegetes.† Rev. A tripod. Leg. in two lines, ΤΑΥΡΟΜΕΝΙΤΑΝ.‡ Weight—$7\frac{1}{2}$ dwts.

28. Teanum Sidicinum.§ Obv. Female head laureated, to l. Leg. in Oscan characters RVNAET [*i.e.* TEANVR reversed.] Rev. Victory crowning a human-faced bull; below, a star. Weight—3 dwts.

29. Panormus. Obv. A head full-faced. Rev. An archer kneeling.‖ Weight—$1\frac{1}{2}$ dwt.

30. Thespiae in Boeotia. Obv. Veiled head, to r. Rev. A lyre within a wreath. Leg. ΘΕΣΠ. Weight—2 dwts.

31. Tyndaris in Sicily. Obv. Head (obliterated.) Rev. Two horsemen.¶ Leg. ΤΥΝ .... ΡΙΤΑΝ.** Weight—$4\frac{1}{2}$ dwts.

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* "Dianae forsan et fratris Apollinis sunt."—Rasche, vii. 989.

† Tauromenium was peopled from Naxus, a neighbouring colony of Chalcideans. These under Thucles, their conductor, going from Euboea, built Naxus, and the altar of Apollo Archegetes, now standing without the city, upon which the ambassadors employed to the oracles, as often as they launch from Sicily, are accustomed to offer their first sacrifice."—Thucyd. vi. 3, p. 341. Vol. ii. Hobbes' Transl.

‡ Doric for Ταυρομενίτων.

§ So called to distinguish it from another Teanum in Apulia.

‖ "Genuflexus sagittarius * * in veteri numo inter Panormitanos."—Rasche vii. 1549.

¶ The Dioscuri. "Clarum Tyndaridae sidus."—Hor. iv. 8. 31.

** Doric for Τυνδαριτων.

32. Zacynthus (Zante). Obv. Head of Diana, to r. Rev. A quiver within a wreath. Leg. ZA. Weight—4½ dwts.

33. Leontini.* Obv. Lion's head, or lion-faced mask. Rev. A palm-tree with fruit. Weight—6½ dwts.

(B) MONARCHICAL.

1. Agathocles of Sicily. (Died B.C. 289.) Obv. Head of Proserpine or Artemis, to r. Leg. .... ΣΩΤΕΙΡ.... Rev. A winged fulmen. Leg. in two lines, ΑΓΑΘΟΚΛΕΟΣ ΒΑΣΙΛΕΟΣ.

2. Phintias of Agrigentum. (Lived B.C. 288.) Obv. Youthful head, to l. Rev. A boar.† Leg. ΒΑΣΙΛΕΟΣ.... Weight—4 dwts.

3. Ptolemaeus I. and Berenice. (Died B.C. 283.) Obv. Head of Ptolemaeus, to r. Rev. Head of Berenice, to r. Leg. ΒΑΣΙΛΕΟΣ ΠΤΟΛΕΜΑΙΟΥ. Weight—1 dwt.

4. Hieronymus of Syracuse. (Died B.C. 215.) Obv. Head of Hieronymus, filleted to l. Rev. A fulmen. Leg. ΒΑΣΙΛΕΟΣ ΙΕΡΟΝΥΜΟΥ.

5. Ptolemaeus IX. (B.C. 107.) Obv. Head of Ptolemaeus in Elephant-scalp, to r. Rev. An eagle standing on a fulmen. Leg. ΠΤΟΛΕΜΑΙΟΥ ΒΑΣΙΛΕΟΣ.

ON THE FAMILIES PROPERLY BELONGING TO THE FISSIROSTRAL SUBORDER OF INSESSORIAL BIRDS, AND THE REAL POSITION OF SOME WHICH HAVE BEEN REFERRED TO IT.

BY REV. WILLIAM HINCKS, F.L.S., ETC.,
PROFESSOR OF NATURAL HISTORY IN UNIVERSITY COLLEGE, TORONTO.

When I laid before the Institute my views respecting the family *Struthionidæ*, I stated my intention, should the opportunity be allowed me, of communicating my conclusions upon some other disputed questions relating to the arrangement of Birds, in pursuance

* In Sicily, south of Catana, five miles inland. Here, in the 5th century B.C., was born Gorgias, the celebrated statesman, orator, and sophist.

† "Apri typus non sine ratione conspicitur, quippe venationi deditus somnium vidit, exitum illi vitae repraesentans; dum scilicet aprum venatur (Phintias), sus in eum ruere, latus ejus ferire dentibus, et vulnere illato ipsum perimere visus. Non caruit somnium eventu."—Rasche vi. 1220.

of which intention I have selected my present subject. Persuaded that the group of Scansorial Birds is too well marked and important to rank only as a sub-order of Insessores, and in fact has as good a claim as Raptores to be accounted an order, I without hesitation assign to it that position; but I cannot follow Dr. George Gray in giving the same distinction to the families of *Columbidæ* and *Struthionidæ*: I have then before me six Orders of the Class AVES, one of which, the Perching-birds, called *Insessores*, exhibits the special bird type most completely, and is vastly more numerous than any of the others. In accordance with views of the classification of the animal kingdom which I have on other occasions endeavoured to explain, defend and apply, and which amount to an attempt to revive with considerable modifications the ideas of McLeay and Swainson, I place the *Insessores* in the centre, with the five other orders placed around them, and I am led to expect to find five sub-orders or great sections of *Insessores*, manifesting certain analogies with the other five orders. The sub-orders of Cuvier, founded on the beak and feet, at once invite attentive examination, and we cannot fail to observe that the *Dentirostres* represent the *Raptores*; the *Conirostres* the *Rasores*; the *Tenuirostres* the *Grallatores* [picking out food from obscure places, with an elongated, generally pointed beak, and in a manner sometimes almost suctorial], whilst the *Fissirostres* [darting at their prey whilst moving in their appropriate element] represent the *Natatores*. If, however, we should be tempted by these analogies to compare Cuvier's remaining sub-order *Syndactyli* with the *Scansores*, we are encountered by difficulties seemingly insurmountable. I was at first disposed to try the effect of this method, but the more I put it to the test, the more evident it became that it completely failed. Still, not readily abandoning principles which seemed to give such beautiful results in a great variety of instances. I returned again and again to the inquiries how the Syndactyli of Cuvier ought to be disposed of, and whether among Insessorial birds, without disturbing the other sub-orders, there really exists any group exhibiting an analogy with the order *Scansores*. These questions soon brought before me the proper limits of the sub-order *Fissirostres*, and having satisfied my own mind by a scheme which, as far as I know, is novel, I submit it to the candid judgment of my fellow-students of nature with no other desire than that it may be considered and fairly judged. It could not fail to be observed that, great as is the authority of Cuvier, and very generally as his other

sub-orders have been acknowledged, his Syndactyles are far from having been received with the same favour, both because the principle upon which they are separated is different in kind from that applied in the other groups, and because there has been a strong feeling that the Syndactyle families find proper places among the other sub-orders. Cuvier's Syndactyli are the Bee-eaters (Meropidæ), the Motmots (Prionitidæ), the Kingfishers (Alcedinidæ) the Todties (Todidæ) and the Hornbills (Bucerotidæ). But there are other birds with syndactyle feet not here included (manikins, for instance), and the character is possessed less perfectly by many birds. If we take the most remarkable cases of syndactyle feet, as the Bee-eaters and the Kingfishers, and consider the effect of the structure, we find that it unfits the bird for walking on branches of trees or on the ground, and is connected with the habit of resting quietly on a branch when not on the wing, and taking prey whilst flying; hence it is a fissirostral character—not constantly, since small feeble feet with short tarsi may be equally connected with this mode of life, but sufficiently to justify the opinion entertained by so many eminent ornithologists that the families first named belong to the Fissirostral group, in which Cuvier, limiting its characters too closely as to the figure of the beak, had only placed the Swallows and Goatsuckers. The small family of Todidæ seems to be best treated as a sub-family of Kingfishers. Another family, nearly related to the Bee-eaters, which is certainly Fissirostral, though with a tendency to the Conirostres, is *Coraciadæ*, the Rollers. Setting aside, then, the Syndactyles by referring their principal families to the Fissirostres, and considering the others as disposable elsewhere, in a way that I shall explain before I conclude, our next object will be to determine the proper limits of the Fissirostral sub-order by reviewing the families which have been by good authorities referred to it. Besides all those which we have already placed in it, and rightly as I think connecting the Jacamars as a sub-family with the Kingfishers, Dr. George Gray adds the Trogons (Trogonidæ) and the Motmots (Prionitidæ). The latter are very deficient in fissirostral characters, and are apparently placed in this position from their supposed (but I think not real) relation to the Bee-eaters. I shall venture an opinion as to their real affinities as we proceed. The beautiful family of the *Trogonidæ* certainly does exhibit fissirostral characters, but they seem to be overbalanced by others of a different kind—the arched beak being finely dentated, and the feet exhibiting

such an approach to the scansorial structure that many have referred the family to the order Scansores; and I believe that it expresses the fissirostral tendency in the sub-order, not yet determined, which represents the Scansores in the great order Insessores. Mr. A. R. Wallace, whose opinions on these subjects always deserve attention, adds the Humming-birds (Trochilidæ), the Puff-birds (Capitonidæ), which he agrees with most recent ornithologists in separating from the Scansorial Bucconidæ, and the Hornbills (Buerotidæ). The Humming-birds, in their power of flight, their feeding on the wing, and their small and feeble feet, undoubtedly exhibit Fissorial characters, but the slender pointed beak, adapted for extracting food from flowers, is most strikingly Tenuirostral, and though the one family has a foot suited for moving on branches, whilst the other relies chiefly on its wings, the relationship between Promeropidæ and Trochilidæ is too close to be disturbed. Regarding Trochilidæ as expressing the Fissirostral tendency among Tenuirostres, we perhaps avoid all real difficulty. Capitonidæ had been also included among the Fissirostres by Dr. G. R. Gray, who treated them as a sub-family of Kingfishers. Mr. Wallace elevates them into a family, and I must think rightly, if we grant their separation from Bucconidæ; but I have hitherto failed to appreciate the reasons for this separation, excepting as sub-families of *Bucconidæ*—the family of Scansores which expresses the Fissirostral tendency. As to Bucerotidæ, their foot, though the two toes are partially united, is not characteristically syndactyle, the expansion of the toes beneath allowing of walking or hopping on branches, and there can hardly be said to be any other fissirostral character. I readily admit that the Hornbills have no real or close affinity with the crows, near which they have been often placed, and their relations with the Toucans, though striking, are more of analogy than immediate affinity. Their mode of life, according to Mr. Wallace's own interesting account, is far removed from that of any Fissirostral family.

Having now decided upon the families which in my judgment can be admitted as truly Fissirostral, it only remains to point out how they severally express the tendencies towards the sub-orders of Insessores, or the five other admitted orders of Birds, in the centre of which we suppose Insessores to be placed. Alcedinidæ, the Kingfishers, manifestly express the Raptorial tendency; the second, the active tendency, shows itself sometimes in arboreal, sometimes in

aerial habits, and seems here to belong to the Swallows (Hirundinidæ), who have most in common with the general body of Insessorial birds. The Rollers (Coraciadæ) display Conirostral affinities, and as far as the essential nature of this group will admit, manifest the Rasorial tendency. The somewhat larger tarsi and the narrow elongated beak, prove the *Meropidæ* (Bee-eater) to look towards the Tenuirostres, and express the Grallatorial tendency. The Caprimulgidæ alone remain, which by their nocturnal habits may be known as the lowest group, and are altogether an exaggeration of whatever is most peculiar to the Fissirostres.

In the course of my examination of Fissirostral birds, I have had occasion to show the reasons which compel me to give up Cuvier's section of Syndactyli, which, indeed, has been abandoned by most recent ornithologists, and from the habits of life arising from the structure being nearly similar to those ascribed to the Fissirostres, could hardly lead to a truly natural grouping. We have now, then, five orders of birds, expressing their remarkable deviations in form and mode of life from the general type, and one much larger order of specially typical birds, in which latter we observe four sub-orders or great sections analogous with four of the other orders, but one of them, the *Scansores,* is without a representative. It surely needs no general theory on the subject to make us feel that something is wanting, and incite us to seek a fifth sub-order of Insessores, bearing a similar relation to Scansores to that which the four received sub-orders do to the other four orders. We should anticipate their possessing some common remarkable character in the beak or feet, or both, with a habit of life imitating in a lower degree that of Scansores; and we might expect to find a series of families bound together by the common characters so as to form a sub-order, though now lying neglected among the other orders of birds. I believe I am in a position to determine this unnoticed sub-order, and point out the families which should be referred to it; and I flatter myself with the hope of thus contributing something towards the improvement of ornithological classification. I name this sub-order *Serratirostres.* They have almost uniformly the margin of the beak serrated or dentated, a character belonging to the Scansorial family Ramphastidæ (Toucans); several of the families, all, indeed, excepting the analogues of the ground birds, whose feet are very peculiar, may be said to have semi-scansorial feet. They all chiefly live on trees. I will name the families thus brought together, and add a very few remarks in justi-

fication of what I propose: Musophagidæ, Coliidæ, Bucerotidæ, Prionitidæ, Trogonidæ, form the group. That the Coliidæ, Musophagidæ and Trogonidæ are nearly related to each other, and exhibit strong Scansorial tendencies, yet not sufficient to place them in the order Scansores, may perhaps be conceded. In the case of the Trogons, which have been placed with Fissirostres, the question is whether Scansorial or Fissirostral tendencies predominate, both being admitted to exist, and looking at the arched—not at all depressed—dentated beak, and the feet with the third toe turned so as to assume some appearance of the true scansorial foot, we ought, I think, to regard the Fissirostral characters of these birds as marking their place in their own circle, not as carrying them amongst the true Fissirostres. More difficulty may be felt respecting the other two families, but the agreement in the serrated beak and generally arboreal habits, and the comparison as to the beak and mode of swallowing, of Bucerotidæ with the Scansorial Ramphastidæ, will go far towards removing difficulty, and possibly among the various stations assigned to the small but distinct family of Prionitidæ none is more probable than that here suggested. I take the fine family of Musophagidæ as the most perfect representative of the Serratirostral type. Since the birds have become better known, the idea of their having any relationship with the Rasores has been abandoned, and they certainly do not present truly Scansorial characters, though a tendency in that direction is unmistakeable. The character of the beak is by no means conirostral, unless we give a very vague extension to that division, and altogether I believe that making this family the foundation of a new sub-order will be felt to remove considerable difficulties. The family of *Coliidæ* is evidently near to Musophagidæ, though abundantly distinguished from it; and the beak, though not precisely serrated is so curiously toothed, and is used so much like a parrot's, that the representation of the Psittacidæ must be readily admitted. The Bucerotidæ occupy the next place, and their analogy with Ramphastidæ with the departure of the feet from the Scansorial tendency, whilst the curved beak, strongly serrated on its margin, and the arboreal mode of life, preserve the connection with the preceding families, may afford good reasons for their position. I cannot but think at least that the common supposition of their near relationship to Crows, and Mr. Wallace's of their belonging to the Fissirostres, will appear to most ornithologists far less tenable than what is now proposed. The Prionitidæ, which I place next, have probably been approximated to Meropidæ from a general resemblance of figure and

elongation of beak, each amongst its own allies representing the Tenuirostral tendency. I have already explained my view of Trogonidæ as in some striking points approaching Musophagidæ, and having well marked the characters of our new sub-order, yet by their power of flight, their feeding on the wing, and their peculiar plumage, sufficiently showing their Fissirostral tendency.

In Mr. Wallace's valuable paper on the natural arrangement of birds, which contains his suggestions respecting the Fissirostral and Scansorial groups, he takes occasion to make an attack on the system of definite numbers in nature, to which I shall take the present opportunity of offering some reply, since, though he immediately refers to Mr. Swainson's system, his arguments, granting their sufficiency, would undoubtedly apply to all schemes which suppose definite tendencies as to number. I might, perhaps, not improperly begin by observing that definite numbers of parts in certain series of organisms being indubitable facts, and yet being fully exposed to one of Mr. Wallace's objections—setting bounds to the variety of Nature —we must receive the fact in preference to a theory, and it perhaps seems to us quite as certain a fact, that the best arrangements in Natural History always show a tendency to the recurrence of the same number of divisions of each great type which can only be accounted for by its occurrence in Nature. Mr. Wallace's first great objection to definite numbers is thus stated by himself:—"Geological investigations prove that the animals now existing in the earth are probably not one-tenth, perhaps not one-hundredth, of those which have existed; for all before the tertiary epoch were of different species and mostly of different genera, and thousands of other genera, families, and whole orders must have existed of which we are absolutely in ignorance. If therefore this regular system were true of the whole, it must be quite imperceptible in the mere fragment we have an acquaintance with. Instead of complete circles being the rule, they should scarcely ever exist; in fact the gaps left in the system by its authors do not leave room enough for all the forms that must have become extinct." Now we believe nobody supposes that if we knew the whole animal creation, past as well as present, we should find all types of structure developed to the same extent, with the same number of families and sub-families, genera and species; and setting this notion aside as altogether preposterous, what is it which is assumed by the advocates of definite number? It is just this, that under each distinct type of structure the minor

divisions will all conform to one or another of a certain set of plans of development, which set of plans or tendencies will equally be found to regulate the variations of every other known type, thus indicating a general order in nature and a certain uniformity in the methods by which the most varied results are produced. Not only does the variety to be called forth under each type or sub-type remain as a subject for observation, but we soon learn that a general type of structure being given, we may have the several plans of development, which give the definite number, repeated in several different grades or degrees of development, for the number of which we know of no definite law, so as in many cases greatly to increase the number of organic forms. Now we believe it is generally agreed that all the organisms of which the remains have been recognized in the strata of the globe conform to the grand types of animal and vegetable structure now known upon the earth. It is therefore the wildest conjecture to suppose that those we do not know may exhibit altogether new and distinct general plans of structure, and as to minor differences they find their place in perfect consistency with regularity of plan. We cannot help regarding Mr. Wallace's estimate of the numbers of extinct creatures as considerably exaggerated, but whatever may be thought on this subject, we must judge of the successive extinct races by the traces of them which remain, and these as clearly indicate a definite plan in Nature, and as certainly prove the uniformity of that plan as a whole, through all periods, as could be desired by the most scrupulous weigher of evidence.

Mr. Wallace's second argument is thus stated: "This system absolutely places limits to the variety and extent of creation; for it is said that every group can only contain five sub-groups, and the number of gradations of groups is fixed. For instance, in a family there can be only five true genera, and again in each group, five sub-genera. In the *Psittacidæ*, therefore, there can be but twenty-five generic forms, and when those are all known, not only is it declared impossible to discover a new one, but it is also asserted that no other can possibly ever have existed and become extinct. This is the logical deduction from any system of definite number in Natural History, and it is one that should convince every person of the false basis on which all such systems rest." I do not know how far this reasoning may apply against Mr. Swainson's system, or some modes of stating it, but I feel very confident that it does not apply to all theories of classification implying the occurrence of definite num-

bers, nor specially to the view of the subject which I am myself recommending. We do not prescribe either through how many steps the subdivision of secondary types needs to be carried, nor how many grades of development a type shall admit. We lay down a general law as founded on observation that under each more general plan of structure the secondary divisions are five, each indicating development in a particular direction, or according to a particular idea, and therefore each having a certain more or less distinctly perceived analogy with the corresponding division under a different type. Such a law indicates a regular natural relation among the members of the animal kingdom, and a definite plan in the mode of adapting different creatures to their different positions; but it places no limit that we can perceive to the extent of creation, and it only opens to us some imperfect view of the means by which the union of order with variety is accomplished. Mr. Wallace takes the example of a particular family (the Parrots) to show that our system exactly fixes how many forms of Parrots can possibly exist in Nature, so that our work is merely to find them and assign to them their places; that we are masters of the limits of nature, and anything out of our scheme is inconceivable. Suppose, then, that we have a definite idea of what constitutes a member of the family of Psittacidæ. If our views be correct, the members of this family will readily fall into five subfamilies, each distinctly exhibiting a certain tendency. If those demand further subdivision, the same tendencies will be again manifested within a more limited field of variation, and this will go on to any required extent, the groups next to the species being genera, or possibly sub-genera, but the number of the intermediate divisions depending on the extent and variability of the family. Would a botanist insist on as many intermediate steps in classification in the order Violaceæ as in Fabaceæ? We have here, then, ample means of disposing of numerous species, provided they all exhibit the kind of relations implied in the sub-families; but suppose even that our researches should bring to our knowledge some birds manifestly not conforming to any of the five sub-families, our law would lead us to expect that they would each still imitate one of the sub-families in its tendency of development, but must belong to a higher or lower grade of development; in either case we extend our actual knowledge of birds, without placing any limit to the variety of creation, yet with a constant sense of the relation of the new object to those previously known, and to a plan which pervades living nature. If

we met with the remains of a species in deposits of as old a date as any in which birds were known to exist, we might be the less surprised if that species exhibited a lower grade of development than living species, and required to be so placed as to direct attention to that fact; but such a circumstance would cause no more difficulty under our system than under any other, and it is evident that Mr. Wallace has been reasoning from a misconception, so far at least as any system of definite numbers is at present maintained.

The law we have proposed may be well defended simply as the general expression of a sufficient number of observed facts, but its interest and value are greatly increased if we are able to trace it to a general principle, and show a connection between it and great truths respecting the structure of the animal kingdom. The living functions of animals are usually reduced under two great divisions, those of animal life which are concerned with sense and motion, and those of vegetative life which include nutrition and reproduction, and which are common to the vegetable with the animal kingdom. The development of the animal functions may be manifested by a high condition of the organs of sense, and a general perfection of the faculties as far as the character of the type will admit, or by a more special development of the motory powers with the other qualities in immediate connection with them, thus forming two distinct plans of development connected with the higher attributes of animal life. In reference to the vegetative life, we may have a higher and a lower grade—the latter being the lowest condition consistent with the type; and also a case for anomalous modes of obtaining and appropriating nourishment, usually accompanied by elongated forms and peculiar habits. These five distinct plans of development may all be worked out in connection with each different type of structure, and the effect is, that whilst the common type establishes affinity, with variations which are commonly expressed by a circular arrangement, a relationship is also perceived between each form and the corresponding mode of development of every other type, producing that complex network of relations which is recognized in nature, and showing how the most marvellous variety is consistent wlth harmonious order and the prevalence of fixed law. To affirm that there is no other conceivable mode of development of a type of structure than will readily come under one of the five tendencies above enumerated might be rash; but to affirm that these are really manifested, are sufficient for the purpose, and consistently explain the

facts observed in the relations of organised beings, may be no more than observation will justify, and reason sanction. For myself, at least, I find such increasing satisfaction in these views of classification that I cannot but hope that as attention is directed to them their value will be perceived. It is, at least to my mind, abundantly evident that the prevalent feeling against anything of definite numbers in classification is either founded on a misunderstanding of what is proposed, or arises from a belief in the origin of species *by accident* which is unsupported by evidence, and unphilosophical in its real character.

ON THE RELATIVE DURATIONS OF THE DIFFERENT WINDS DURING RAIN OR SNOW, DERIVED FROM THE TORONTO OBSERVATIONS, IN THE YEARS 1853 TO 1859, INCLUSIVE.

BY G. T. KINGSTON, M.A.
DIRECTOR OF THE PROVINCIAL MAGNETIC OBSERVATORY, TORONTO.

The relations between rain or snow and the direction of the wind may be viewed either with reference to the winds that precede, to the winds that accompany, or to those that succeed the fall. In this paper it is proposed to consider the second of these questions only.

A comparison will be made of the relative durations of the winds, from the sixteen principal points, *throughout days* of rain or snow, including the hours in which no rain or snow fell, as well as the actual time of falling; and a similar and separate comparison will also be made of the relative durations of the winds whose occurrence was limited to the *hours* in any part of which a fall took place.

As some winds have a greater general prevalency than others, it is requisite that the absolute duration of each wind during rain should be divided by its absolute duration, with and without rain, in the same series of years. The quotients form what may be termed the *relative durations* of the several winds during rain, and constitute the proper quantities for intercomparison.

As it is probable that the lighter showers may give a greater prominence to certain winds than is their due, and may also diminish, in-

some degree, the preponderance of those which are properly the rainy winds, the distribution of the winds, when no regard is had to the amount of rain that fell in the day, and the distribution of the winds when the total fall in the day was equal to or exceeded half an inch, have been shewn separately.

Table I. shews the distribution of the winds among the different points of the compass *throughout days* of rain. The process employed in the computation will be understood by referring to the table itself.

Column (1) contains the absolute number of hours that each wind blew during the days in any part of which either heavy or light rain occurred during the years 1853 to 1859. Column (2) contains the duration of each wind on days wherein the rain was equal to or exceeded half an inch. Column (3) gives the absolute number of hours that each wind blew during the same seven years.*

From the quotients, which are given in column (4), we learn that of 1000 hours in which the wind blew from E.N.E. as many as 545 hours belonged to days during some part of which rain fell; but that of 1000 hours of north wind, only 248 were included in days of rain. Also from column (5), obtained in a similar manner from columns (2) and (3), it appears that of 1000 hours of wind from E.N.E., 126 hours were comprised in days on which the rain that fell was not less than half an inch, and that only 14 hours in 1000 of W.S.W. winds occurred on days wherein the rain reached that amount.

The comparative magnitudes of the numbers in column (4) are better seen by aid of the ratios which they severally bear to their arithmetic mean. These ratios, and the ratios similarly obtained from column (5), are given in columns (6) and (7).

From column (6) it appears that during days in which rain fell to a greater or less amount, the winds from N.E. through south to S.W. had a duration above or not below the average duration of all winds, and that winds from N.N.E through north to W.S.W. had a less than average duration. It is also seen that the wind of most frequent occurrence is from E.N.E., and that of least frequent occurrence from either north or N.N.W.

When the heavier rains only are taken into account, the winds whose relative durations are above the average, lie between N.E. and S.S.E.;

* The entries in these three columns are furnished from the hourly records made by Robinson's Anemometer.

the maximum continues at E.N.E., but the minimum is transferred to W.S.W. The range between the durations for the different points is also greatly increased; the E.N.E. wind being nearly nine times as frequent as the wind from W.S.W., during days of heavy rain; whereas when days of light as well as heavy rain are considered, the range is little more than 2 to 1. The progression in column (6) is determined chiefly by the rains under half an inch; for if the heavier rains be excluded by subtracting column (5) from column (4), the positions of the maximum and minimum in the resulting series of numbers remain the same as in column (6), and the winds that have a more than average duration lie, as in column (6) between N.E. through south to S.W. The predominance of the E.N.E. wind will be still less than in column (6); the ratio to the mean being only 1.41, and the range less than 2 to 1.

During the year 1857 to 1859 a record was made each day of the *hours* during any part of which rain or snow was seen to fall, or was believed to have fallen, from the best evidence that could be procured at the time when the entries were made. The want of any instrument for recording the hours in which a fall took place, precluded any more certain mode of procuring the requisite facts; but although the entries do not claim the same confidence as those made at the regular observation hours, or by aid of self-registering instruments, it is believed that they furnish very fair data for determining approximately the relative frequency of the winds that blew during the same hours with rain or snow.

The distribution of the winds among the several points of the compass during the hours in which rain fell is shewn by Table II.

Column (1) gives the number of hours during any part of which rain fell, arranged according to the direction of the wind during the same hour. Column (2) gives the corresponding numbers when rain amounting to less than half an inch in the day is excluded. Column (3) gives the total duration of each wind within the same period, namely, the years 1857 to 1859, inclusive.

The quotients arising from the division of the numbers in (1) and (2) by those in (3), and which are entered in columns (4) and (5), are measures of the frequency of rain for each wind. Thus, of 1000 hours in which the wind was from E.N.E. it rained during some part of each of 219 hours; but it rained in 39 hours only of 1000 hours of a N.W. wind.

From column (6) it appears that during hours of rain, winds between N.N.E. through east to S.S.W., with an interruption at south, have a relative duration above the average relative duration of all winds, and winds from north through west to S.W. have a duration below the same average. The wind that most frequently occurs during hours of rain is from E.N.E.; and the N.W. wind is that which is most rarely accompanied by rain.

For the heavier rains we see from column (7) that the winds whose duration is above the average are limited to the four points N.N.E. to East. The range is also greatly increased, the E.N.E. wind being 18 times as frequent as the N.W. wind; whereas when lighter rains are included, the E.N.E. wind is less than 6 times as frequent as the N.W. wind.

The increase of the ranges in Table II. as compared with those in Table I. is explained by the circumstance that westerly and northwesterly winds, though blowing seldom during the actual fall of the rain, frequently occur during some part of the days in which rain falls, particularly after the rain has ceased, and thus tend to conceal or diminish the predominance of the E.N.E. winds that is so conspicuous in Table II.

The distribution of the winds throughout days of snow is exhibited in Table III.

With the view of examining whether the distribution of the winds is affected by the magnitude of the snow storm, the method employed in computing Table I. has been applied in Table III. to the following four classes, whereof each class is taken so as to include all the higher classes:

Class I. includes every instance in which snow was recorded.

Class II. is limited to those cases wherein the snow in twenty-four hours was equal to or exceeded one inch.

Class III. is limited to falls of three inches and upwards.

Class IV. is limited to falls of six inches and upwards.

From column (6) it appears, when light falls and the heaviest snow storms are ranked together indiscriminately, that 291 hours in 1000 hours of N.E. winds, 330 hours in 1000 of west winds, and 86 hours in 1000 of south winds are included in days of snow. Also, from column (10), the winds whose duration during days of snow are above the average for all winds, lie between N.E. through north and west to

S.W., all inclusive, the duration of the other winds being below the average. The progression is double, the chief maximum being at west and the principal minimum at about south or S.S.W., with a second maximum at N.E. and a second minimum at or near N.W.

This apparent predominance in the relative frequency of west winds is due to the lighter falls of snow. By subtracting the numbers in (7) from those in (6) and taking the average of the remainders, it is found that the winds above the average lie between N.N.E. through west to S.W., all inclusive, the N.E. wind being slightly *below* the average and the west wind occurring more than twice as frequently as the N.E. wind. The progression becomes single, the maximum being at west, and the minimum about S.S.W., with a sudden drop between S.W. and S.S.W., as well as another between N.E. and E.N.E.

Comparing the four final columns of Table III. we find that the second maximum at N.E. in column (10) becomes very decidedly the principal maximum in column (11), wherein snow amounting to less than one inch in the day is excluded, and increases greatly as the storm becomes more heavy. The west wind also, which was the principal maximum when light snow was included, is now decidedly below the average, and rapidly decreases in frequency in columns (12) and (13). The north wind maintains a more than average frequency till the falls of snow are limited to those of six inches and upwards.

The progressive increase in the predominance of winds from the five points N.N.E. through east to E.S.E., in passing from Class I. to Class IV., and the diminished frequency of other winds, are made apparent by the averages of the ratios for the former five points, and for the remaining eleven points.

AVERAGE RATIOS.

	Class I.	Class II.	Class III.	Class IV.
Five winds from N.N.E. to E.S.E.	1.00	1.70	2.10	2.55
Eleven remaining winds, -	1.04	0.74	0.57	0.35

In Table IV. the distribution of the winds is shewn during the *hours* in any part of which snow fell.

When no distinction is made between falls of widely different amount, it is seen by column (10) that the winds from north to E.N.E. are decidedly above the average, the most prevalent wind being from N.E. For the other points of the compass the winds are mostly be-

low the average; but there is a trace of a second maximum between W.N.W. and W.S.W.

The distribution of the winds during falls of which the amount is less than one inch, will be found by subtracting the relative durations in column (7) from those in column (6). The progression in the resulting series, omitting minor irregularities, becomes single; the maximum is decidedly between the three points W.N.W., west, and W.S.W., and the minimum is in the S.E. quadrant, the winds from N.E. being well below the average.

On comparing the four final columns in Table IV. we find that the principal maximum at N.E., in column (10), increases rapidly in the higher classes, and that the second maximum at or near west in column (10), disappears when the snow amounts to one inch. The north wind continues above the average during falls of snow equal to or exceeding one inch, but falls below the average when snow amounting to less than three inches is excluded, and is wholly absent when the storms included are only those of six inches and upwards. It appears further, by comparing Tables III. and IV., that although during some part of the day in which a snow storm of the heaviest class takes place, the wind may blow more or less from any point of the compass; during the actual fall of the snow the directions of the wind are limited to the four points N.N.E., N.E., E.N.E., and east.

The increasing frequency in the easterly group of winds from N.N.E. through east to E.S.E., *during the actual fall of snow,* as more and more of the lighter falls are excluded, and the diminishing frequency of all other winds, are shewn by the averages of the corresponding ratios, in the manner already employed with reference to Table III.

AVERAGE RATIOS.

	Class I.	Class II.	Class III.	Class IV.
Five winds from N.N.E. to E.S.E.	1.41	2.16	2.59	3.22
Eleven remaining winds, -	0.84	0.52	0.33	0.00

TABLE I.

Comparative duration of the several winds during days in any part of which rain fell, from observations in the years 1853 to 1859 inclusive, the falls that include heavy or light rain indiscriminately, and such as are limited to half an inch or upwards in the day being considered separately.

	Absolute duration of the several winds expressed in hours.			Relative duration of each wind during the days in which rain fell as compared with its whole duration for the seven years.		Ratios of the numbers in (4) and (5) to their respective means for all winds.	
Direction of the wind.	During days of heavy or light rain. (1)	Rain ½ inch and upwards during the day. (2)	During days with and without rain (3)	Ratios of (1) to (3). (4)	Ratios of (2) to (3). (5)	Rain generally. (6)	Rain ½ an inch and upwards. (7)
N	969	118	3908	0.248	0.030	0.72	0.64
N N E	687	107	2579	.266	.041	0.77	0.88
N E	961	171	2635	.365	.065	1.06	1.40
E N E	2142	497	3929	.545	.126	1.58	2.71
E	2375	515	4572	.519	.113	1.50	2.43
E S E	977	173	2298	.425	.075	1.23	1.61
S E	606	85	1647	.368	.052	1.07	1.12
S S E	681	102	1818	.375	.056	1.09	1.20
S	965	94	2795	.345	.034	1.00	0.73
S S W	1538	163	4021	.382	.041	1.11	0.88
S W	1421	147	4000	.355	.037	1.03	0.80
W S W	1297	62	4415	.294	.014	0.85	0.30
W	1249	73	4571	.273	.016	0.79	0.34
W N W	1157	100	4455	.260	.022	0.76	0.47
N W	1160	88	4426	.262	.020	0.76	0.43
N N W	1258	106	5061	.249	.021	0.72	0.45
Calms.	1283	115	3921	.327	.029	0.95	0.62

TABLE II.

Comparative duration of the several winds during the hours in any part of which rain fell, from observations in the years 1857 to 1859, rains generally and the falls amounting to half an inch and upwards in the day being considered separately.

	Absolute duration of the several winds expressed in hours.			Relative duration of each wind during the hours in which rain fell as compared with its whole duration for the three years.		Ratios of the numbers in (1) and (5) to their respective means for all winds.	
Direction of the wind.	Rain generally. (1)	Rain ½ inch and upwards. (2)	During hours with and without rain (3)	Ratios of (1) to (3). (4)	Ratios of (2) to (3). (5)	Rain generally. (6)	Rain ½ an inch and upwards. (7)
N	92	26	1489	0.062	0.017	0.68	0.67
N N E	118	42	770	.153	.055	1.68	2.18
N E	102	40	1022	.100	.039	1.10	1.55
E N E	471	236	2149	.219	.110	2.41	4.37
E	288	94	2192	.131	.043	1.44	1.71
E S E	116	18	876	.132	.021	1.45	0.83
S E	68	11	661	.102	.017	1.12	0.67
S S E	75	15	781	.096	.019	1.05	0.75
S	94	18	1166	.081	.015	0.89	0.60
S S W	172	31	1799	.096	.017	1.05	0.67
S W	129	37	1760	.073	.021	0.80	0.83
W S W	103	21	1945	.053	.011	0.58	0.43
W	107	17	1975	.054	.009	0.59	0.36
W N W	92	14	2044	.045	.007	0.49	0.28
N W	80	12	2027	.039	.006	0.43	0.24
N N W	115	22	2213	.052	.010	0.57	0.39
Calms.	85	16	1388	.061	.012	0.67	0.48

TABLE III.

Comparative duration of the several winds during the days in any part of which snow fell, from observations in the years 1853 to 1859, inclusive, the snow storms being arranged in four classes, according to the amount of snow, and each class being taken to include all the higher classes.

	Absolute duration of the several winds in hours.					Relative duration of each wind on days of snow as compared with its duration in all days.				Ratios of the numbers in (6) (7) (8) and (9) to their respective means for all winds.			
	Snow generally. (1)	Snow 1 inch and upwards. (2)	Snow 3 inches and upwards. (3)	Snow 6 inches and upwards. (4)	During days with and without Snow. (5)	Ratios of (1) to (5). (6)	Ratios of (2) to (5). (7)	Ratios of (3) to (5). (8)	Ratios of (4) to (5). (9)	Snow generally. (10)	1 inch and upwards. (11)	3 inches and upwards. (12)	6 inches and upwards. (13)
N	909	236	97	11	3908	0.233	0.060	0.025	0.003	1.21	1.15	1.18	0.83
N N E	705	294	119	19	2579	.273	.114	.046	.007	1.41	2.19	2.17	1.94
N E	766	403	190	38	2635	.291	.153	.072	.014	1.51	2.94	3.40	3.89
E N E	533	269	171	34	3929	.136	.068	.044	.009	0.70	1.31	2.08	2.50
E	526	236	128	27	4572	.115	.052	.028	.006	0.60	1.00	1.32	1.67
E S E	330	125	74	22	2298	.144	.054	.032	.010	0.75	1.04	1.51	2.78
S E	212	75	27	4	1647	.129	.046	.017	.002	0.67	0.88	0.80	0.56
S S E	165	43	12	1	1818	.091	.024	.007	.001	0.47	0.46	0.33	0.28
S	239	62	15	0	2795	.086	.022	.005	.000	0.45	0.42	0.24	0.00
S S W	350	102	14	4	4021	.087	.025	.003	.001	0.45	0.48	0.14	0.28
S W	800	147	27	7	4000	.200	.037	.007	.002	1.04	0.71	0.33	0.56
W S W	1372	161	50	10	4415	.311	.036	.011	.002	1.61	0.69	0.52	0.56
W	1509	212	56	3	4571	.330	.046	.012	.001	1.71	0.88	0.57	0.28
W N W	1161	165	45	3	4455	.261	.037	.010	.001	1.35	0.71	0.47	0.28
N W	1000	176	64	5	4426	.226	.040	.014	.001	1.17	0.77	0.66	0.28
N N W	1223	261	107	2	5061	.241	.052	.021	.000	1.25	1.00	0.99	0.00
Calms.	504	81	28	2	3921	.129	.021	.007	.001	0.67	0.40	0.33	0.28

TABLE IV.

Comparative duration of the several winds during the *hours* in any part of which snow fell, from observations in the years 1857 to 1859, inclusive, the snow storms being arranged in four classes, according to the amount of snow, and each class being taken to include all the higher classes.

	Absolute duration of the several winds expressed in hours.					Relative duration of each wind during the hours in which snow fell, as compared with its duration in all hours.				Ratios of the numbers in (6) (7) (8) and (9) to their respective means for all winds.			
	Snow generally. (1)	Snow 1 inch and upwards. (2)	Snow 3 inches and upwards. (3)	Snow 6 inches and upwards. (4)	During days with and without Snow. (5)	Ratios of (1) to (5). (6)	Ratios of (2) to (5). (7)	Ratios of (3) to (5). (8)	Ratios of (4) to (5). (9)	Snow generally. (10)	1 inch and upwards. (11)	3 inches and upwards. (12)	6 inches and upwards. (13)
N	105	43	9	0	1489	0.071	0.029	0.006	0.000	1.24	1.07	0.59	0.00
N N E	100	72	10	2	770	.130	.094	.013	.003	2.27	3.48	1.29	2.04
N E	143	117	60	11	1022	.140	.114	.059	.011	2.45	4.22	5.84	7.48
E N E	139	89	64	14	2149	.065	.041	.030	.007	1.14	1.52	2.97	4.76
E	82	58	34	8	2192	.037	.026	.016	.003	0.65	0.96	1.58	2.04
E S E	28	15	11	0	876	.032	.017	.013	.000	0.56	0.63	1.29	.00
S E	31	14	2	0	661	.047	.021	.003	.000	0.82	0.78	0.29	.00
S S E	36	9	4	0	781	.046	.012	.005	.000	0.80	0.44	0.49	.00
S	21	7	3	0	1166	.018	.006	.003	.000	0.32	0.22	0.29	.00
S S W	49	20	7	0	1799	.027	.011	.004	.000	0.47	0.41	0.39	.00
S W	85	26	5	0	1760	.048	.015	.003	.000	0.84	0.56	0.29	.00
W S W	113	19	6	0	1945	.058	.010	.003	.000	1·01	0.37	0.29	.00
W	110	16	5	0	1975	.056	.008	.003	.000	0.98	0.30	0.29	.00
W N W	125	21	2	0	2044	.061	.010	.001	.000	1.07	0.37	0.10	.00
N W	91	25	2	0	2027	.045	.012	.001	.000	0.79	0.44	0.10	.00
N N W	125	47	10	0	2213	.056	.021	.005	.000	0.98	0.78	0.49	.00
Calms.	48	13	6	1	1388	.035	.010	.004	.001	0.61	0.37	0.39	0.68

NOTE ON TRILINEARS.

1. *The property of transversals.*

With the usual notation, let the sides c, a, b of the triangle of reference ABC, taken in order, be divided by the points F, D, E, respectively in the ratios $p:q$, $q:r$, $r:p$. Then the equations to the lines CF, AD, BE respectively are

$$\begin{aligned} pa\alpha - qb\beta &= 0, \\ qb\beta - rc\gamma &= 0, \\ rc\gamma - pa\alpha &= 0, \end{aligned}$$

and the three lines meet in the point

$$pa\alpha = qb\beta = rc\gamma.$$

Again, the equations to the lines DE, EF, FD are

$$\begin{aligned} pa\alpha + qb\beta - rc\gamma &= 0, \\ qb\beta + rc\gamma - pa\alpha &= 0, \\ rc\gamma + pa\alpha - qb\beta &= 0, \end{aligned}$$

and if these lines be produced to meet each the remaining side of the triangle, the three points of section lie in the line

$$pa\alpha + qb\beta + rc\gamma = 0.$$

Also, the equations to the lines joining these points of section each to the remaining vertex of the triangle, are

$$\begin{aligned} pa\alpha + qb\beta &= 0, \\ qb\beta + rc\gamma &= 0, \\ rc\gamma + pa\alpha &= 0, \end{aligned}$$

and these with the sides of the triangle and the three first-mentioned lines form harmonic pencils at the vertexes of the triangle.

Cor. 1. This includes the following well-known cases:

(1) If $p=1$, $q=1$, $r=1$, we have the bisecters of the sides.

(2) If $p=b\cos A$, &c, we have the perpendiculars from the angles on the sides.

(3) If $p=b$, $q=c$, $r=a$, we have the bisecters of the angles.

(4) If $p=\cot\frac{A}{2}$, &c., we have the lines from the angles to the points of contact of the inscribed circle.

COR. 2. The case of a dividing point lying in a side produced is included by making the ratio negative.

2. *The equations to a line.*

Let (α, β, γ) be the coordinates of some arbitrary point in the line; $(\alpha', \beta', \gamma')$ current coordinates; r the distance between these points; then we have

$$\frac{\alpha'-\alpha}{l} = \frac{\beta'-\beta}{m} = \frac{\gamma'-\gamma}{n} = r,$$

where l, m, n, are constants connected by the relation

$$al + bm + cn = 0.$$

This is obvious, because the numerators of the above ratios are the projections of r on lines perpendicular to the sides of the triangle. Also since

$$a\,\alpha' + b\,\beta' + c\,\gamma' = 2 \text{ Area of triangle},$$
$$a\,\alpha + b\,\beta + c\,\gamma = \text{same},$$

it follows that

$$a(\alpha'-\alpha) + b(\beta'-\beta) + c(\gamma'-\gamma) = 0,$$

and therefore

$$al + bm + cn = 0.$$

Hence also the equations to a line which passes through two points (α, β, γ), $(\alpha_1, \beta_1, \gamma_1)$, are

$$\frac{\alpha'-\alpha}{\alpha-\alpha_1} = \frac{\beta'-\beta}{\beta-\beta_1} = \frac{\gamma'-\gamma}{\gamma-\gamma_1}.$$

3. *The tangent to a conic.*

Let $\phi(\alpha, \beta, \gamma) = 0$, be the general equation to the conic, ϕ being homogeneous and of the second order. The tangent to this at the point (α, β, γ) being the line through the points (α, β, γ) and $(\alpha + d\alpha, \beta + d\beta, \gamma + d\gamma)$, its equations will be

$$\frac{\alpha'-\alpha}{d\alpha} = \frac{\beta'-\beta}{d\beta} = \frac{\gamma'-\gamma}{d\gamma}.$$

But, from the equation to the curve,

$$\frac{d\phi}{d\alpha}\cdot d\alpha + \frac{d\phi}{d\beta}\cdot d\beta + \frac{d\phi}{d\gamma}\cdot d\gamma = 0,$$

therefore the equation to the tangent becomes

$$(\alpha'-\alpha)\frac{d\phi}{d\alpha} + (\beta'-\beta)\frac{d\phi}{d\beta} + (\gamma'-\gamma)\frac{d\phi}{d\gamma} = 0,$$

and since, by the property of homogeneous functions,

$$\alpha \frac{d\phi}{d\alpha} + \beta \frac{d\phi}{d\beta} + \gamma \frac{d\phi}{d\gamma} = 0,$$

the equation finally reduces to

$$\alpha' \frac{d\phi}{d\alpha} + \beta' \frac{d\phi}{d\beta} + \gamma' \frac{d\phi}{d\gamma} = 0.$$

4. *The polar of a point.*

Let (α, β, γ) be the point; $(\alpha_1, \beta_1, \gamma_1)$, $(\alpha_2, \beta_2, \gamma_2)$ the points of contact of the two (real or imaginary) tangents drawn from it to the conic.

The equations to these tangents are

$$\alpha' \frac{d\phi}{d\alpha_1} + \beta' \frac{d\phi}{d\beta_1} + \gamma' \frac{d\phi}{d\gamma_1} = 0,$$

$$\alpha' \frac{d\phi}{d\alpha_2} + \beta' \frac{d\phi}{d\beta_2} + \gamma' \frac{d\phi}{d\gamma_2} = 0,$$

and since (α, β, γ) lies in each of these, we have the relations,

$$\alpha \frac{d\phi}{a\alpha_1} + \beta \frac{d\phi}{d\beta_1} + \gamma \frac{d\phi}{d\gamma_1} = 0,$$

$$\alpha \frac{d\phi}{d\alpha_2} + \beta \frac{d\phi}{d\beta_3} + \gamma \frac{d\phi}{d\gamma_2} = 0,$$

and these, by the property of homogeneous functions, are equivalent to

$$\alpha_1 \frac{d\phi}{d\alpha} + \beta_1 \frac{d\phi}{d\beta} + \gamma_1 \frac{d\phi}{d\gamma} = 0,$$

$$\alpha_2 \frac{d\phi}{d\alpha} + \beta_2 \frac{d\phi}{d\beta} + \gamma_2 \frac{d\phi}{d\gamma} = 0,$$

and the points $(\alpha_1, \beta_1, \gamma_1)$, $(\alpha_2, \beta_2, \gamma_2)$ therefore lie in the line

$$\alpha' \frac{d\phi}{d\alpha} + \beta' \frac{d\phi}{d\beta} + \gamma' \frac{d\phi}{d\gamma} = 0,$$

which is therefore the equation to the polar of (α, β, γ).

Cor. Since the centre is the pole of the line at infinity, the equation

$$\alpha' \frac{d\phi}{d\alpha} + \beta' \frac{d\phi}{d\beta} + \gamma' \frac{d\phi}{d\gamma} = 0$$

will, when the centre is pole, be identical with

$$a\,\alpha' + b\,\beta' + c\,\gamma' = 0,$$

and therefore

$$\frac{1}{a}\,\frac{d\phi}{d\alpha} = \frac{1}{b}\,\frac{d\phi}{d\beta} = \frac{1}{c}\,\frac{d\phi}{d\gamma}$$

determine the coordinates of the centre.

This result may be obtained independently as follows:

4. *The centre of a conic.*

Let the conic $\phi\,(\alpha, \beta, \gamma) = 0$ be cut by the line

$$\frac{\alpha'-\alpha}{l} = \frac{\beta'-\beta}{m} = \frac{\gamma'-\gamma}{n} = r.$$

Then for the points of section

$$\phi\,(\alpha, \beta, \gamma) + \left(l\frac{d\phi}{d\alpha} + m\,\frac{d\phi}{d\beta} + n\,\frac{d\phi}{d\gamma}\right)\,r + Rr^2 = 0,$$

and, if l

$$\frac{d\phi}{d\alpha} + m\,\frac{d\phi}{d\beta} + n\,\frac{d\phi}{d\gamma} = 0,$$

the two values of r are equal and opposite, and the point (α, β, γ) is the centre of the chord. If then the above condition be satisfied for *all* values of l, m, n, consistently with the condition

$$al + bm + cn = 0,$$

all the chords through (α, β, γ) are bisected by it, and (α, β, γ) is the centre. Comparing the two conditions, we have

$$\frac{1}{a}\,\frac{d\phi}{d\alpha} = \frac{1}{b}\,\frac{d\phi}{d\beta} = \frac{1}{c}\,\frac{d\phi}{d\gamma}$$

for determining the centre.

Cor. If the conic be such that the triangle of reference is self-conjugate with regard to it, its equation is

$$u\,\alpha^2 + v\,\beta^2 + w\,\gamma^2 = 0,$$

and the centre is given by

$$\frac{u}{a}\,\alpha = \frac{v}{b}\,\beta = \frac{w}{c}\,\gamma.$$

If the conic be a circle, then

$$\frac{u}{a\cos A} = \frac{v}{b\cos B} = \frac{w}{c\cos C},$$

and the centre is given by

$$\alpha \cos A = \beta \cos B = \gamma \cos C,$$

that is, it is the intersection of the perpendiculars from the angles on the sides of the triangle.

If the conic be an equilateral hyperbola, then

$$u + v + w = 0,$$

and the coordinates of the centre satisfy the condition

$$\frac{a}{\alpha} + \frac{b}{\beta} + \frac{c}{\gamma} = 0;$$

that is, the locus of the centre is the circumscribing circle of the triangle.

Univ. Coll. J. B. C.

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OBSERVATIONS ON SUPPOSED GLACIAL DRIFT IN THE LABRADOR PENINSULA, WESTERN CANADA, AND ON THE SOUTH BRANCH OF THE SASKATCHEWAN.

BY HENRY YOULE HIND, ESQ., M.A., F.R.G.S.,
PROFESSOR OF GEOLOGY IN TRINITY COLLEGE, TORONTO.

(From the Proceedings of the London Geological Society.)

CONTENTS.

§ 1. *The Boulders on the flanks of the Table-land of the Labrador Peninsula.*

During an exploration of a part of the interior of the Labrador Peninsula in 1861, I had an opportunity of observing the extraordinary number, magnitude, and distribution of the erratics in the valley of the Moisie River and some of its tributaries, as far north as the

south edge of the table-land of the Labrador Peninsula (lat. 51° 50′ N., long. 66° W.), and about 110 miles due north of the Gulf of St. Lawrence. Boulders of large dimensions, 10 to 20 feet in diameter, began to be numerous at the Mountain Portage, 1460 feet above the sea, and 60 miles in an air-line from the mouth of the Moisie River. They were perched upon the summits of peaks estimated to be 1500 feet above the point of view, or nearly 3000 feet above the sea-level, and were observed to occupy the edges of cliffs, to be scattered over the slopes of mountain-ranges, and to be massed in great numbers in the intervening valleys.

At the "Burnt Portage" on the north-east branch of the Moisie, nearly 100 miles in an air-line from the Gulf of St. Lawrence, and 1850 feet above the ocean, the low gneissoid hills for many miles round were seen to be strewed with erratics wherever a lodgment for them could be found. The valleys (one to two miles broad) were not only floored with them, but they lay there in tiers, three or more deep. Close to the banks of the rivers and lakes near the "Burnt Portage," where the mosses and lichens have been destroyed by fire, very coarse sand conceals the rocks beneath, but on ascending an eminence away from the immediate banks of the river the true character of the country becomes apparent. At the base of the gneissoid hills which limit the valley of the east branch (about three miles broad) at this point, they are observed to lie two or three deep, and although of large dimensions, that is from 5 to 20 feet in diameter, they are nearly all ice- or water-worn, with rounded edges, and generally polished or smoothed. These accumulations of erratics frequently form tongues, or spots, at the termination of small projecting promontories in the hill-ranges. I have several times counted three tiers of these travelled rocks where the mosses, which once covered them with a uniform mantle of green, had been burnt; and occasionally, before reaching the sandy area which is sometimes found on the banks of the river, I have been in danger of slipping through the crevices between the boulders, which were concealed by mosses, a foot and more deep, both before and after passing through the "Burnt Country," which has a length of about 30 miles where I crossed it. I extract the following note from my journal of the appearance of these travelled rocks in the "Burnt Country":—

"Huge blocks of gneiss and labradorite lie in the channel of the river, or on the gneissoid domes which here and there pierce the sandy tract through which the river flows. On the summit of the

mountains, and along the crest of the hill-ranges, about a mile off on either side, they seem as if they had been dropped like hail. It is not difficult to see that many of these rock-fragments are of local origin, but others have evidently travelled far, on account of their smooth outline. From a gneissoid dome, I see that they are piled to a considerable height between hills 300 and 400 feet high; and from the comparatively sharp edges of many around me, the parent rock cannot be far distant."

On all sides of Cariboo Lake, 110 miles in an air-line from the Gulf, and 1870 feet above it, a conflagration had swept away trees, grasses, and mosses, with the exception of a point of forest which came down to the water's edge and formed the western limit of the living woods. The long lines of enormous unworn boulders, or fragments of rocks, skirting the east branch of the Moisie at this point were no doubt lateral glacial moraines. The coarse sand in the broad valley of the river was blown into low dunes, and the surrounding hills were covered with millions of erratics. No glacial striæ were observed here, but the gneissoid hills were rounded and smoothed at their summit; and the flanks were frequently seen to present a rough surface, as if they had been recently exposed by land-slides, which were frequently observed, and the cause which produced them, namely, frozen waterfalls.

No clay or gravel was seen after passing the mouth of Cold-water River, 40 miles from the Gulf, and 320 feet above it. The soil, where trees grew, was always shallow as far as observed; and although a very luxuriant vegetation existed in secluded valleys, yet it appeared to depend upon the presence of labradorite-rock or a very coarse gneissoid rock, in which flesh-coloured felspar was the prevailing ingredient.

Observers in other parts of the Labrador Peninsula have recorded the vast profusion in which erratics are distributed over its surface. There is one observer, however, well known in another branch of science, who has left a most interesting record of his journey in the Mistassinni country, between the St. Lawrence, at the mouth of the Saguenay and Rupert's River, in Hudson's Bay. André Michaux, the distinguished botanist, traversed the country between the St. Lawrence and Hudson's Bay in 1792. He passed through Lake Mistassinni; and in his manuscript notes, which were first printed in 1861, for private circulation, at Quebec, a brief description of the journey is given. "The whole Mistassinni country," says Michaux,

"is cut up by thousands of lakes, and covered with enormous rocks, piled one on the top of the other, which are often carpeted with large lichens of a black colour, and which increase the sombre aspect of these desert and almost uninhabitable regions. It is in the spaces between the rocks that one finds a few pines (*Pinus rupestris*), which attain an altitude of three feet; and even at this small height showed signs of decay."

The remarkable absence of erratics in the Moisie, until an altitude of about 1000 feet above the sea is attained, may be explained by the supposition that they may have been carried away by icebergs and coast-ice during a period of submergence, to the extent of about 1000 feet. I am not aware that any traces of marine Shells or marine drift have been recognized, north of the Labrador Peninsula, at a greater elevation than 1000 or 1100 feet. In the valley of the St. Lawrence marine drift has not been observed higher than 600 feet above the sea. Glacial striæ were seen on the "gneiss-terraces" at the "Level Portage," 700 to 1000 feet above the sea. The sloping sides of these terraces are polished and furrowed by glacial action. Grooves half an inch deep, and an inch or more broad, go down slope and over level continuously. It is on the edge of the highest terrace here that the first large boulders were observed.

The entire absence of clay, and the extraordinary profusion of both worn and rugged masses of rock piled one above the other in the valley of the east branch of the Moisie (fig. 1), as we approach the table-land, lead me to attribute their origin to local glacial action, as well as the excavation of a large part of the great valley in which the river flows. Its tributary, the Cold-water River, flows in the strike of the rocks through a gorge 2000 feet deep, excavated in the comparatively soft labradorite of the Labrador series.*

The descriptions which have recently been published† of different parts of the Labrador Peninsula not visited by me, favour the supposition that the origin of the surface-features of the areas described

* See Sir William Logan's 'Geology of Canada' (1863). on the Division of the Laurentian Rocks into "two formations":

1st. The Labrador series.

2nd. The Laurentian.

The Labrador series, I have been recently informed by Sir William Logan, has been ascertained by him to rest unconformably upon the older Laurentian, and will be distinguished by a separate colour on his new Map of Canada. See also Mr. Sterry Hunt on the Chemistry of Metamorphic Rocks.

† See my 'Explorations in the Interior of the Labrador Peninsula.' Longmans, 1863.

may be due to glacial action, similar to that observed in the valley of the Moisie River.

§ 2. *The Forced Arrangement of Blocks of Limestone, &c., in Boulder-Clay.*

The forced arrangement of blocks of limestone, slabs of shale, and boulders of the Laurentian rocks, in the Blue Clay at Toronto, formed the subject of a paper which I read before the Canadian Institute seven years ago. A minute description of this arrangement was published in my Report of the Assinniboine and Saskatchewan Exploring Expedition in 1859,* to illustrate a similar arrangement of blocks of limestone and gneissoid rocks in the clay on the south branch of the Saskatchewan observed in 1858.

I concluded the description of this remarkable arrangement with the following hint at their origin:—"May not the plastic and irresistible agent which picked up the materials composing the Blue Clay, and then melting, left them in their present position, have been largely instrumental in excavating the basins of the great Canadian lakes?"†

And, in 1860, in a 'Narrative of the Canadian Expeditions," I remarked, "The widespread phenomena exhibiting the greater or less action of ice, such as grooved, polished, and embossed rocks, *the excavation of the deep lakes of the St. Lawrence basin,* the forced arrangement of drift, the ploughing-up of large areas, and the extraordinary amount of denudation *at different levels,* without the evidence of beaches, all point to the action of glacial ice previous to the operations of floating ice in the grand phenomena of the Drift."‡

§ 3. *The Driftless Area in Wisconsin.*

In a recent Report on the Geological Survey of the State of Wisconsin, by the distinguished American geologists, Professors James Hall and J. D. Whitney, the remarkable view is advanced by the latter, that there is an area of more than 3000 square miles in extent (long. 90° W., lat. 42° 50' N.) which has never been overflowed since the Upper Silurian epoch. Mr. Whitney says‡, "If we consider the magnitude and universality of the drift-deposits in

* Report on the Assinniboine and Saskatchewan Exploring Expedition. By Henry Youle Hind, M.A., Toronto, 1859. Eyre and Spottiswoode, London, 1860 (Blue Book.)

† *Op. cit.* (Toronto), p. 122.

‡ Narrative of the Canadian Expeditions of 1847 and 1858, vol. ii. p. 254. Longman's 1860.

the Northern United States, and especially in Northern Wisconsin, we shall be the more astonished to learn that throughout nearly the whole Lead-region, and over a considerable extent of territory to the north of it, no trace of transported materials, boulders, or drift can be found; and what is more curious, to the east, south, and west, the limit of the productive Lead-region is almost exactly the limit of the area thus marked by the absence of Drift."

The conclusions to which Mr. Whitney has been led by the study of this driftless region are briefly as follow:—

1. That since the Upper Silurian period this portion of Wisconsin has not been submerged, and that its surface has, consequently, never been covered by Drift.

2. That the denudation it has undergone has been effected by the simple agency of rain and frost.

3. That a large portion of the superficial detritus of the West must have had its origin in the subaërial destruction of the rocks, the soluble portion of them having been gradually removed by the percolating water.

4. The entire absence of terraces indicates that the region in question has not been submerged in recent times. No organic remains other than those belonging to palæozoic times, except those of land animals and plants, have been found in the Lead-region.

On the railway between Milwaukie (Lake Michigan) and Prairie du Chien on the Mississippi, there is no point which rises higher than 950 feet above the sea-level; and the towns of Galena, Menomonee, and Dunlieth, in the Lead-region, are below the level of Lake Michigan.

§ 4. *Beaches and Terraces.*

In connexion with this driftless area, the beaches and terraces which form so distinguishing a feature in North America acquire particular interest.

Confining myself to those terraces which have come under my own observation, I shall notice first the vast bank of sand, 55 miles west of Lake Superior, commonly called the Great Dog Portage.* The altitude of the summit of this terrace is 835 feet above Lake Superior, more than 800 feet above Lake Michigan, and 1435 feet above the sea.

* For a description of the Great Dog Portage, see 'Narrative of Canadian Exploring Expeditions of 1857 and 1858.' Also Reports on the North-west Territory, 1859. By the Author.

One hundred and twenty miles west of Lake Winnipeg the successive steps or terraces of the Riding and Duck Mountains rise in well-defined succession on the south and south-western slopes; but on the north-east and north sides they present a precipitous escarpment more than 900 feet in altitude, or 1000 feet above Lake Winnipeg, or 1600 feet above the sea; while Lake Traverse, which sends water during floods to the Red River of the north as well as to the Mississippi, is only 966 feet above the same level; and from 10 to 15 miles west of Lake Traverse and Big Stone Lake (966 feet above the sea) is the abrupt escarpment of the Côteaux des Prairies, whose summit is 1000 feet above them.

Illustrations of a precipitous escarpment on one face, with gentle sloping plateaux separated by terraces on the other side, might be greatly multiplied; they are indeed the common feature in the scenery of the basin of Lake Winnipeg, west of that lake; and, with a single known exception, mentioned by Dr. Hector*, the precipitous escarpment faces the north-east or the north, and the terraces and plateaux the south or south-west. This feature is also observed in all the outliers in the great prairies and plains of the basin of Lake Winnipeg. The terraces of Lake Superior and the escarpments, with their corresponding terraces in the Lake Winnipeg basin, considered in relation to the driftless area in Wisconsin, point to the former existence of great glacial lakes, as suggested by Mr. Jamieson to explain the origin of the Parallel Roads of Glen Roy. The clean-swept floor of the level country at the foot of the great escarpment of the Riding, Duck, and Porcupine Mountains, in which Lake Winnipeg and its associated lakes lie, indicates the boundary of a vast glacier, which excavated their basins and left its dirt-beds on the prairie country even as far as the south branch of the Saskatchewan, where I observed the forced arrangement of slabs in *unstratified clay* in 1858.

§ 5. *Anchor-ice—Excavation of Lake-basins.*

It has been frequently stated that a difficulty arises as to the *modus operandi* by which a moving glacier can excavate lake-basins. May not the manner in which stratified rocks, at least, over which a glacier may be moving, be involved in its mass in the form of slabs or mud, constituting dirt-beds, be partially explained by the phenomena attending the formation of 'anchor-ice'? It is no

* The Cyprès Hills, Quart. Journ. Geol. Soc. vol. xvii. p. 399.

uncommon occurrence for the anchors of the nets of a "seal-fishery" on the north shore of the Gulf of St. Lawrence to be frozen to the bottom at the depth of from 30 to 60 feet; and when anchors are then raised, they bring with them frozen masses of sand. But it is in rapid rivers that the formation of anchor-ice is most remarkable, and most effective in excavating these beds. It forms on the beds of rivers above the head of a rapid, and frequently bursts up with a load of frozen mud or shingle, or slabs of rock, which it has torn from the bottom. This phenomenon is witnessed every winter in the valley of the St. Lawrence, but it is best observed after a prolonged term of cold, when the thermometer indicates a temperature considerably below zero. Anchor-ice has only been observed, as far as my knowledge of the subject goes, in rapid currents in open water; and the sudden and apparently inexplicable rise of the St. Lawrence during extreme cold is most probably due to this cause.* It is not difficult to see how the rivers issuing from beneath the precipitous walls of glaciers, as described by Dr. Rink, may rapidly excavate deep channels by means of anchor-ice, to be widened by the subsequent operations of the glacier itself. Nor is it improbable that by this means a glacier in very cold climates may increase from the bottom upwards with a load of frozen mud and fragments of rock, particularly near its base, when that does not meet the open sea. The great lakes of North America, including Lake Winnipeg, are excavated on the edges of the fossiliferous rock-basins; and these lakes may represent the boundary of a glacial mass similar to that which now covers Greenland.

§ 6. *Parallelism of Escarpments in America.*

In 1860† I described the remarkable parallelism which exists between great escarpments in America north of the 40th parallel of latitude.

1st. The Niagara escarpment.

2nd. The Riding, Duck, and Porcupine Hill escarpment, west of Lake Winnipeg.

3rd. The escarpment of the Grand Côteau de Missouri.

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* See "Notes on Anchor-ice," by C. T. Keefer, C.E., Canadian Journal, New Series, vol. vii. p. 173 (1862.)

† See my 'Narrative of the Canadian Exploring Expeditions of 1857 and 1858,' vol. ii. p. 266, for a notice of these escarpments.

These are all roughly parallel to one another, and are many hundred miles in length. The lowest, the Niagara, varies from 600 feet to 1300 feet above the sea; the second, west of Lake Winnipeg, from 1600 feet to 2000; the third, the Grand Côteau de Missouri, from 2000 to 3000 feet and more above the ocean (see fig. 3.) They have all easterly, north-easterly, or northerly aspects, in relatively different parts of their lengths,* and appear to have a common origin. If it can be shown conclusively, as Mr. Whitney believes, that the driftless area in Wisconsin has never been overflowed, these escarpments, as well as those of their great outliers in the "far West," can only be due to the same agent which excavated the basins of the great American lakes.

The symmetrical escarpments of the Grand Côteau de Missouri, the Riding Mountain and its prolongations, and portions of the Niagara escarpments, are probably the result, to a large extent, of the action of glacial rivers undermining and washing away the soft strata of the sedimentary rocks, and excavating *in advance* of the glacial mass itself; and they represent different and closely succeeding glacial periods (the Missouri escarpment being older than that of the Riding Mountain), with, however, a distinct geological interval between them. The close proximity of the isothermal curves in these latitudes to the general direction of the escarpments of the Grand Côteau and Riding Mountain is a very interesting and important feature in connexion with the cause which produced them.

§ 7. *Conclusion.*

The opinion that many of the phenomena attending the surface-geology of a large portion of North America were caused by glacial ice, appears to be gradually gaining ground among American geologists. First enunciated by Professor Louis Agassiz,† it received the sanction, wholly or in part, of some well-known geologists. In a recent paper by Dr. Newberry, it is stated that "in this 'glacial epoch' all the Lake-country was covered with ice, by which the rocky surface was planed down and furrowed, and left precisely in the condition of that beneath modern moving glaciers in mountain-valleys"‡.

* The western exception at Cyprès Hills has been already noticed. Here the flanks of the Rocky Mountains are approached.

† Lake Superior: its Physical Character, Vegetation, and Animals, &c. 1850.

‡ Notes on the Surface-geology of the Basin of the Great Lakes.

Dana considers "the glacial theory the most satisfactory, but the iceberg-theory required, in some cases, for the borders of continents."*

Sir William Logan, when speaking of the innumerable lakes scattered over the Laurentian region of Canada, says, in his 'Geology of Canada,' just published, "The rock which is most characteristic of the depressions is the comparatively soft crystalline limestones of the series; and it appears probable that one of the main erosive forces has been glacial action."

Also, with reference to the great Lake-basins, he says, "These great Lake-basins are depressions, not of geological structure, but of denudation; and the grooves on the surfaces of the rocks, which descend under the water, appear to point to glacial action as one of the great causes which have produced these depressions."†

I have great satisfaction in observing that the views which I published in 1859,‡ respecting the origin of the great American lakes and other glacial phenomena in North America, are continually receiving additional support from various sources; and I venture to think that it is not unreasonable to suppose that we shall find in North America the parallel of that widespread work of ancient glaciers in Europe, which has been so ably described before the Society by its distinguished President, Professor Ramsay.

PALÆONTOLOGY.

(Translated from the Comptes Rendus, Feb. 29, 1864.)

Upon some new Observations of Messrs. Lartet and Christy, relative to the existence of Man in the centre of France, at a period when that country was inhabited by the Reindeer and other animals, which do not live there at the present day.

BY M. MILNE EDWARDS.

The interest which surrounds all facts calculated to enlighten us upon the characteristics of the Gallic Fauna at the period when man

* Dana's 'Manual of Geology,' 1863, p. 546.

† Geological Survey of Canada, 1863, page 889.

‡ See Reports of the Assiniboine and Saskatchewan Expedition. In 1855 I read a paper before the Canadian Institute, Toronto, "On the Origin of the Basins of the Great Lakes, advocating the view that they had been excavated by means of ice.

began to inhabit this part of Europe, has made me resolve to submit, for the inspection of the Academy, some of the specimens recently discovered by Messrs. Lartet and Christy, in one of the numerous ossiferous caverns of the centre of France. These objects are remarkable for more than one reason; and to exemplify their importance, I cannot do better than present here a letter, which has just been addressed to me by the former of these able and zealous explorers:

Sir,—In support of the remarks which you have communicated at one of the late sittings of the Academy, on the subject of animal figures carved on bone, and found in the cavern of Bruniquel, I come in my own name and also in that of Mr. H. Christy, a member of the London Geological Society, to cite to you many other facts of the same nature. For the present we shall confine ourselves wholly to mentioning the discoveries we made during the five last months of the year 1863, in that part of ancient Périgord which now constitutes the district of Sarlat.

One of the grottoes of that region—that of Eyzies, in the parish of Tayac—has exhibited to us in a conglomerate covering the soil like one continuous floor, an amalgam of broken bones, cinders, fragments of charcoal, and splinters and laminæ of flint cut upon different plans, but invariably in definite and oft-repeated forms, accompanied by other utensils and arms worked in the bones or horns of the reindeer. The whole of this must have been taken up and solidified into a conglomerate in the original condition of deposit, and before any geological change, because series of many vertebrae of the reindeer and assemblages of joints in multiple pieces are found remaining in their exact anatomical connections; the long and hollow marrow-bones are alone detached, and split or broken according to a uniform plan, that is to say, evidently with the intention of thence extracting the marrow. This proposition of ours can, moreover, be confirmed by all competent observers, for we were careful to have this conglomerate extracted in large plates, and after having deposited the finest specimens in the Museum of Périgueux and in the collection of the Jardin des Plantes at Paris, we have addressed to different French and foreign museums, blocks of sufficient size to enable any one to verify the exactness of the observations which we here record.

This grotto of Eyzies, the mouth of which is 35 metres above the level of the nearest watercourse, the Beune, contained also many pebbles and fragments of rocks foreign to the basin of that little

stream, and which must have been introduced there by human agency. Some of those pebbles of considerable bulk, principally those of granite, are flattened on one side, rounded in their contour, and scooped out on the top, with a cavity of greater or less depth, which presents traces of repeated rubbing.

There were also in the grotto of Eyzies numerous fragments of a schistoid rock of considerable hardness, and upon two plates of this rock we could discern partial representations of animal forms engraved in outline. We suppose that these are the first observed examples of engraving upon stone in that ancient phase of the human epoch, when the reindeer still inhabited the temperate regions of the Europe of our day. Upon one of those plates, which has come to our hands in an imperfect state in consequence of an ancient fracture, may be distinguished the fore part of a quadruped—probably of a herbivorous species—and the head of which must have been armed with horns, so far at least as one can judge from lines of engraving undecided in their character, and penetrating but slightly into this rock, which is relatively so hard. On the other plate we recognize more readily a head, with clearly defined nostrils, and half open mouth; but the outlines are interrupted in the frontal region by a sort of erasure, resulting from a fracture, apparently artificial, and subsequent to the engraving. Beside, and a little in advance of this, we distinguish the design of a large palm-like figure, which, if it really belongs to this head, would lead us, as you were the first to suggest, to assign it to the elk. Besides the ossiferous deposits of the interior of the caverns, which are so numerous in Périgord, we can also study there analogous accumulations of organic remains, leaning against the large escarpments of the cretaceous limestones of this district, and sometimes simply sheltered by projections of rocks more or less overhanging. These external deposits are equally rich in cut flints and in the broken bones of animals,—the horse, the ox, the wild goat, the chamois, the reindeer, birds, fish, &c.,—which evidently served as food for the indigenous tribes during this ancient period of the stone age. The remains of the common stag are here very rare, as well as those of the wild boar and the hare. We found there some isolated teeth of the gigantic stag of Ireland (*Megaceros Hibernicus*), and some detached laminæ of molars of the elephant (*E. primigenius*) precisely as we have observed them at the scenes of the funeral entertainments of the ancient burial-places of Aurignac, without being

any better able to explain for what actual use these laminæ of teeth thus isolated were intended.

It is also in the external deposits that we have collected the finest cut flints, especially at that of Laugerie-Haute, which seems to have been the site of a manufactory of those spear-heads cut to little splinters upon both faces, and slightly undulating upon the edges. But it is probable we found there only the refuse of this manufacture, for few specimens presented themselves in a perfect state among more than a hundred fragments which we have taken out.

At Laugerie-Basse, half a league down the stream, and still upon the banks of the Vezère, there was probably another workshop for arms and implements of reindeer's horn, to judge from the enormous quantity of remains of horns of that animal which are found accumulated there, and which almost without exception bear marks of a sawing, by means of which the pieces intended to be worked up were detached. There in particular we were able to procure,—in addition to arrows and barbed harpoons, which are found in nearly all the deposits of this age,—that great variety of utensils which will be submitted for the inspection of the Academy, and some of which are ornamented with elegant carvings of a workmanship truly astonishing, when we consider the means of execution which these tribes could have possessed, unacquainted as they were with the use of metals. You will remark among them those needles of reindeer's horn, finely pointed at one end, and pierced at the other with a hole or eye, intended to receive a thread of some kind.

There are also tools raised at the extremity with blunt notches, which would permit of the conjecture that they were used for making nets. Teeth of sundry animals—the wolf and the ox—pierced at their root, must have served for ornaments, as well as other objects fashioned like ear-drops, sometimes from the ivory part of the ear-bones of the horse or the ox.

Another object already found by one of us in the vault of Aurignac, respecting which he thought he ought to maintain silence, in spite of the value of an observation as yet unique, is represented at both the stations of Laugerie, and at that of Eyzies. It is a first hollow *phalanx* of certain herbivorous ruminants, which is pierced artificially beneath, a little in front of its metacarpal or metatarsal joint. On applying the lower lip to the articular hollow, and then blowing into the hole, you obtain a sound resembling that which is produced by a

hollow key of moderate size. It cannot be doubted that it was a call-whistle in common use amoug these tribes of hunters, for up to the present we have observed four examples of it,—three of which are made of *phalanges* of the reindeer and the fourth of a *phalanx* of the chamois.

At Laugerie-Basse, moreover, thanks to the intelligent superintendence and minute precautions of M. A. Laganne, who was charged with the direction of our excavations, we have obtained many bits of reindeer's horn, which despite the alterations made by time, still preserve, in whole or in part, very distinct representations of animal forms. Some are simply traced in outline upon the branch or terminal expansion of the frontal prolongations of the reindeer; others are truly sculptured either in bas-relief, or even in round emboss-ment, or full relief upon the shanks of the same animal, prepared for that effect.

One of these branches, from which an old breakage has obliterated a part of the design, still gives us the exact outlines of the hind quarters of a large herbivorous animal, traced by a sure hand. The thinness of the tail, the slight curvature of the hams, and especially the very advanced position of the sign of the male sex, do not permit us to consider it meant for a horse; we should rather recognize it as a bovine form, and the abrupt rise of the line of the back near the shoulder would seem to point to the ure-ox. Unfortunately, the interruption of the design by the fracture of the piece occurs just at the point where the tufted hair or characteristic bristles of the bison family should commence.

On a second branch of greater size, we discover another form, evidently bovine in its character, to judge by the hams and the spurs placed behind the divided hoof.

In this, the thicker tail, the greater horizontality of the line of the back, and a smooth dewlap hanging between the forelegs, indicate a nearer approach towards the ox properly so called (Query—*Bos primigenius?*) A fracture has once more removed the region of the head to which the horns were attached, and the artist—in order to make use of the divisions of the antlers—must have given to the animal a twisted attitude, which injures the general effect of the sketch. A third branch, on which the graving is preserved a little more perfectly, shows us an animal whose head is armed with two horns rising vertically at first, and then bending back towards their point. Behind

these horns, a faintly defined trace of ears is perceived; and beneath the chin, that of a tuft of hair or a beard, peculiarities which would suggest readily enough a female wild goat, if they were not contradicted by a perceptible curving of the forehead and a swelling of the neck behind the ears, which would seem to forbid this conjecture. In this figure, moreover, the designer has, without any apparent necessity, folded back the hind extremities under the animal's belly, in such a way that its finely divided hoofs touch the abdomen.

Among the carved specimens coming from this same locality of Laugerie-Basse, we may quote a rounded staff made of the shank of a reindeer's horn, and terminated at one end by a spear-point with a lateral recurrent hook. Was this a utensil, a weapon, or a symbol of authority? We cannot say. Immediately above the hook we perceived carved in half relief upon three of its faces a horse's head, with ears lying down, and a little long for the species, but not sufficiently so to permit of our assigning this figure to the ass. Farther on, but still in the continuation of the staff, we meet with a second head with delicate snout and armed with branching horns. The basilary antlers are carved in front upon the horizontal prolongation of the staff, while the butt and the neck and shoulders are projected in a reverse direction behind; the slender shape of the head, where no trace of a muzzle is perceptible, the apparent lengthening of one of the basilary antlers, and the entire physiognomy of this figure would induce us to attribute it to the reindeer rather than the elephant stag. In front of the snout of this head, we find still another figure simply engraved in outline, and which might be well enough accepted as the form of a fish.

There is another capital specimen in which the art sentiment is specially revealed by the skill which the artist has displayed in adopting animal forms to the necessities of common use, without doing them too much violence. It is a dagger or short sword of reindeer's horn, of which the whole handle is formed of the body of an animal; the hind legs are lying down in the direction of the blade; the head, which has the snout elevated, forms with the back and rump a hollow intended to facilitate the grasping of this weapon by a hand necessarily much smaller than those of our European races. The head is armed with branching horns, which are united to the sides of the neck and shoulders, without interfering in the slightest degree with the grasp; but the basilary antlers must have been suppressed. The ear is much smaller than that of the stag, and in its position also approaches more

closely to that of the reindeer; lastly, the artist has left under the shoulder a projection, slight and jagged upon its edges, which presents a fair imitation of the tuft of hair often found in this position in the male reindeer. It is to be regretted that this specimen should have come to us in the state of a mere rough outline, as we may judge by the unfinished workmanship of the blade, and certain faintly indicated details of carving.

Now, if it were necessary to adduce fresh evidence in addition to that already furnished to prove the co-existence of man and the reindeer in those regions which have become our central and meridional France, we might mention pretty numerous horns of that animal, at the root of which we distinguish gashes made in detaching them from the skin. We would also direct attention to other transverse gashes or incisions which we frequently observe at the base of the hoofs of the reindeer of our caverns, and which have been produced by the cutting of the tendons, made, as the Esquimaux still do at the present day, with the intention of splitting these tendons, and dividing them into threads which were used to stitch the skins of animals, and also to plait cords of great strength. Lastly, we could further shew a vertebra of the back of the reindeer, pierced through and through by a flint weapon which has remained fixed in the bone, where it is retained by a calcareous incrustation. After that, as archæological circumstances fitted to characterize the era of the reindeer in France, we confine ourselves to mentioning this one, viz., that of seventeen stations where we have discovered the presence of this animal in a state of subjection to human agency, there is not one in which we have observed traces of polish upon the stone weapons; and, nevertheless, it is by many thousands that we have there collected flints, cut in all varieties of types, and passing through all gradations of perfection of workmanship, from the roughly sketched forms of the hatchets of the drift of Abbeville and Saint-Acheul to the heads of spears with multiplied faces and with the elegant waving edges of the finest periods of the stone age in Denmark.

As to the epoch at which the reindeer ceased to inhabit our temperate Europe we have not upon this point any historical data or positive chronology. The reindeer was not seen or clearly described by any writer of antiquity. Cæsar has only spoken of it by hearsay, and as of an animal still existing somewhere in a forest of which the extreme boundaries could not be reached even after a march of sixty days. We have not recognized the reindeer among the animals repre-

sented upon the ancient coins of Gaul. We have not found its bones in the dolmens and other vaults styled Celtic in which are frequently found associated the remains of wild and domesticated animals, and in which we have observed on two occasions in the neighbourhood of Paris the bones of the beaver. The reindeer has not, as far as we know, been yet found in the peat mosses of France. Messrs. Garignon and H. Tilhol have not recorded its presence in certain caverns of the Ariége which they have justly assimilated by their zoological characteristics and also by the presence of instruments of polished stone to the most ancient lake-dwellings of Switzerland. We know that up to the present the reindeer is missed among the fauna of this marine crib-work, and yet we have been able to study its remains coming from a cavern of the neighbourhood (that of Mont-Salève) where the association of flints simply cut, and of mammals belonging to the same period, is shewn under the same condition as in our grottoes of Perigord.

Thus, let the disappearance of the reindeer from our temperate Europe be the result of the local extinction of this species, or of its being driven back by the progressive development of human societies, or, if you choose, of its gradual and voluntary retreat in consequence of changes in the climatic conditions, it is not less probable that this disappearance dates back to a phase of the pre-historic times prior to the introduction of the domesticated races and the employment of the metals in our Western Europe.

The Academy will remark that in the letter of Messrs. Lartet and Christy, as well as in the communication which I had the honor of recently making on the subject of the cavern of Bruniquel, no mention has been made of human bones found as well in this latter locality as in the grotto of Eyzies.

This silence is explained by the fact that the epoch of the burial of these remains seems to us possibly less ancient than that from which dates the accumulation of reindeer bones and instruments of flint or wrought bone.

Note upon some new proofs of the Existence of Man in the Centre of France, at an epoch when certain animals were found there which do not inhabit that country at the present day.

BY M. DE VIBRAYE.

The history of the human family in its cradle still presents some points of obscurity which it is highly important to set about the task of removing. I think, therefore, that I may advance the interests of science, by briefly communicating some of the observations, which numerous tours, undertaken in the course of the year 1863, have enabled me to collect, while exploring caverns, bone-bearing fissures, and land slides.

I will repeat the expression which I used before the Geological Society of France in 1860, that my evidence cannot be suspected, because I have shared in the doubts that have been entertained with respect to the co-existence of man and animals, some belonging to extinct species, and others that have migrated to other quarters of the globe in consequence probably of a modification of climate and of conditions—a modification of which the cause is still undetermined.

I considered it my duty to extend my investigations to the monuments pertaining to that age, which by common consent is termed the celtic era. I shall not here describe the flint instruments and the specimens of pottery which I have succeeded in collecting; it is enough for me to invite attention to the obscurities which surround this epoch. In view of the difficulties that beset us, it is of use, I think, to take every opportunity of making comparisons, and to prepare a classification of the age of stone, that shall be in some measure chronological.

According to the generally accepted opinion, the time has not yet come for attributing without criticism to the first ages of mankind, certain polished instruments found alongside of flints bearing traces of a ruder workmanship. Would the diluvial gravels present us with any specimens, as well as the monuments reputed to be celtic? All that I can vouch for is what the beds of caverns characterized by the presence of numerous bones of the reindeer, notched, fractured, or even wrought, supplied me with:

1. In the Fairies' Cave (Arcy-sur-Eure, Yonne) a hatchet or rather a tomahawk of amphibolite of which the workmanship would not

disgrace the celtic age; on the other side a saccharoid limestone evidently worn away by friction.

2. The deposits of Tayac and of Tursac (Dordogne) have furnished under the same conditions specimens of granite, squared or rounded at the edges, and hollowed in the centre, intended beyond doubt for grinding grain. In presence of these authentic facts the most philosophical course is to refuse our consent to the systematic elimination of these objects from the reputed diluvial beds, and for my own part I cannot *a priori* reject the theory of their antiquity.

But before pronouncing an opinion it will be well to recur to the stratigraphic study of caverns and bone-bearing fissures, and all the land-slides—a study which furnishes a powerful test that perhaps has been too frequently neglected.

I have, like many other persons, explored the valley of the Somme; this served for a starting point, but it was necessary to proceed in search of new facts, and to correct the observations made in some localities that had been too superficially explored.

The department of Loir-et-Cher has furnished at a great number of points flint instruments: *nuclei*, knives, hatchets, spear-points, round or kidney-shaped balls which had served as hammers for making splinters. These different implements are found in the sub-soil, or even at the surface, when they have been turned up by the plough. They invariably accompany the drift so generally seen in Sologne on the table-lands, and are always met with at points where the underlying geological formations crop out; at some points, gravels or shell-marl grits, at others the upper limestone beaches of the system of Beauer, and at others chalk layers.

On the 19th of July, our colleague, M. De Verneuil drew my attention to the same facts near Sacy-le-Grand, at 120 yards below the level of the Oise. A diluvium covers the lignite-clays of Soissonnais. Here flint splinters bestrew the soil, many of them characterized by workmanship of considerable fineness of execution. Here, as every where else, (not even excepting the banks of the Somme and the caverns) the traces of a natural polish upon the flints seem to me to deserve a minute examination. Should these traces be attributed to the pressure of blocks driven along by the currents? The fact is general and demands an explanation.

The most useful study to undertake is the establishment of a correlation between the flint-stones and the animal remains which accompany them, when destructive agencies, and especially the dissolvent

action of carbonic acid upon bones, permit the recognition of traces of the fauna of the ancient world. Thus at Vallières (Loir-et-Cher) in a cave nearly dried up, as well as in an osseous breccia which surrounds it, filling fissures of cretaceous rocks, there have been found bones of the *Hyaena Spelaea,* the *Rhinoceros Tichorhinus,* the *Cervus Megaceros,* the *Bos Primigenius,* the *Equus Adamiticus,* &c., accompanied by hatchets analogous to the specimens collected in the Valley of the Somme.*

Thrice during the year 1863 I have extended my investigations over the departments of Dordogne and Charento; at Bourdeille, Tayac and Tursac, in the former of these departments; at Combe-de-Rolland, La Roche-Andry, Montgaudier, and La Chaise, in the latter.

In most of these localities we can prove the existence of hearth-stones, where upon layers of calcareous formations (oolitic or cretaceous) have been placed, as better calculated to resist the action of heat, various chrystalline rocks foreign to the country. Upon these hearth-stones we find mixed with cinders and fragments of coal, or even imbedded in a pretty tough conglomerate, thousands of flint instruments, and a multitude of articles worked in bone, needles of great fineness artistically bored, awls, fish-hooks, barbed arrows, spoons which from their shape might have served for the extraction of marrow, daggers manufactured from the horns of the reindeer, ornaments in intaglio or worked in relief upon the bones. Nay, further, the representation of the stag and the hind, the dog and the ox, an otter or a beaver, of an animal with a thick mane wanting the head, and lastly of many birds and fish. A reindeer's head projects from the handle of a dagger; thus we recognize the first rudimentary attempts at carving—I would even venture to add, at statuary. The excavations of Tayac have furnished me with some fragments of the molars and tusks of the elephant, and I think we must assign to the spoils of this monster the reproduction of a human type—the statuette of a woman.

No doubt two observers of the highest authority will favor the learned world with their fruitful discoveries. I shall not anticipate the valuable communications of Mr. Christy of London, and M. Lartet, the kind guide of my earliest palæontological studies, the

* I may here observe that the flint-knives of Vallières are more highly finished, and display more after-touch than those which, in the lower bed of the cave of Arcy, are associated with the fauna of extinct species.

master whom I shall always consult in the numerous cases where prudence requires me to hesitate.

If the existence of hearth-stones at somewhat numerous points, but most frequently at the bottom of valleys, as, for instance, on the brink of water courses, and the revelation of a civilization which it would be erroneous at the present day to term rudimentary, should be urged as objections to the *relative* antiquity of these first inhabitants of the globe, I will reply that wrought flints, split by fire, are met with in the gravels of the table-lands, but the objects which accompanied them have without doubt been dispersed, swept away by the waters. The siliceous matter, from the double advantage of its specific gravity and of its indestructability, has alone been strong enough to resist the great currents, while bony and gelatinous substances have disappeared, as I before indicated, under the destructive influence of atmospheric agents. But, on the other hand, it is necessary to examine the fauna of these hearth-stones: it is identical with those of the bone-bearing conglomerates which surround and cover them; the remains of the reindeer, the urus, the ox and the horse, are found associated with numerous flint-stones of a workmanship of sufficient finish at a certain number of points to be compared to instruments of the same nature attributed to the Celtic epoch. It is especially at Combe-de-Rolland, near Angoulême, and at Bourdeilles (in the grotto of the Ass and Devil's Furnace) that the finest types are met with. In the parishes of Tayac and Tursac the instruments are less perfect, but, in return, bones adapted for use abound.* The hearth-stone of Roccoutteux at Bourdeilles; the grottoes of La Chaise and of Montgaudier, near Montbron, have furnished analogous specimens, but in smaller number. At Bourdeilles wrought flints are met with in the valley, but they are again found at all heights, and in the defiles.† They were undoubtedly carried along by the impetuosity of the same currents as have worn away the rocks not only in the sloping parts of the valley of erosion, but up to the summit of the table lands. If we were tempted to attribute to some convulsion the deposition of the Ass' Cave at Bourdeilles, I would observe that the calcareous sediments are found even in the upper part of this cave, and that they contain

* Utensils, arms, or designs, 252; reindeer horns, notched or sawed, 260; stag horns in the same state, 9.

† The exploration of this defile has led to the discovery of a human molar, which I succeeded in taking out with my own hands.

imbedded in them the finely wrought flints which I have mentioned above. It must be admitted on the other hand, that in order to have been precipitated through a fissure, the presence of which can be clearly traced to its summit, animals such as the reindeer, the wolf, &c., must have dwelt at more elevated levels. At some points of these human stations, these hearth-stones, the spoils of animals belonging to extinct races are found; at Montgaudier some rare relics of the *Hyæna-spelæa*; at La Chaise, the *Rhinoceros tichorhinus*; in the hearth.stone of Laugerie, the elephant is represented by some fragments of molars and a certain number of instruments. Already, in preceding years, I had collected in the Fairies' grotto some molars of the *Elephas Primigenius* and objects in wrought ivory, which a preconceived idea made me eliminate too arbitrarily from the middle bed, more or less properly termed the red or upper drift.

Last year I thought I ought to examine still more minutely the Fairies' grotto. The principal point was to establish incontestably the co-existence of man with extinct races and with species that have migrated towards the north. My late excavations have furnished me with corroborative proof of the first of these two facts. When I began in 1858, I had, like all inexperienced explorers, proceeded by the tentative method, and I saw myself compelled, in the presence of numerous obscurities, to suspend my judgment. The most efficacious method of dispelling the reasons for my hesitation, was to explore in succession the superposition of the beds, and especially to exhaust the upper strata with a view to the study of the lower drift. It was under these conditions, and when the intermediate stratum (the red drift) had entirely disappeared, that an intelligent and learned coadjutor, M. Franchet, who accompanied me to the caverns, drew out with his own hands at the base of the lower stratum, and almost on the very rock, a human *Atlas* associated with numerous bones of the bear and the hyæna of the caverns. The very aspect of this human relic, even apart from the circumstances in which it was found, would serve to indicate its origin. This is the fifth example in six years of human bones obtained from this lower stratum, and collected at diverse points, but *always* in direct relation with extinct races, and under the same conditions of burial, without any trace of a later convulsion. The floor of the Fairies' Cave has fallen into decay at a certain number of points, and separates the inferior layer from the middle stratum. After

having laboriously raised, by means of iron-pincers, the flag-stones belonging to the lower oolite, and sometimes to the coral rag, the excavations change in character, and it is no longer with the reindeer, but with the bear and the hyæna, the elephant and the rhinoceros, that I have myself extracted from this lower layer the wrought flints and the fractured bones, which the workmen could not discover in the middle of the moist and sticky substances of clay, in which the flints and bones are imbedded. In presence of these layers, separated by a sinking of the surface, I asked myself whether it was possible to separate chronologically the two stages. Does the superposition of the strata in this connection belong to the geological order? Do not the existence of cinders and coal, and of wrought bones, and the wrought flints accumulated in such numbers in the upper stratum, as well as the scarcity of intact bones, seem to denote here the exclusive intervention of man for the formation of these depositaries as the *kjœkkenmoeddinger* of Norway, and certain accumulations of remains accompanying the lake deposits. Up to the time when the extinct races had seemed confined to the lower stratum, that hypothesis might have been absolutely rejected; but if, on the one hand, still existing, though migrated, races, are found to belong to both stages, and if, on the other hand, the relics of extinct races are associated with existing species in the bosom of the workshops of primitive human industry, what are we to think of this double association?

In any case the artificial, or if you will, the natural layer, where the bones of the reindeer abound, and where hearthstones are met, has preceded one of the convulsions of the globe, as is proved by the presence of numerous angular fragments of the surrounding rocks, and by the rolled pebbles derived from crystalline rocks, mixed into a perfect conglomerate with flint implements and wrought bones. This layer is very different, it may be remarked by the way, from the lake deposits, in which the animal remains without exception belong to the modern and local fauna, which no change in the earth's condition warrants our separating from our own epoch. I should note here the discovery of crude metals associated with the bones of the caverns. The negative fact of their absence in the bosom of the drift layers had led to the *a priori* admission that the men of these remote times were completely ignorant of their use, when they were perhaps only deprived of the means of using them, although they had preserved the

traditional notion of their value.* I picked up in the lower bed of the caverns of Arcy (the stratum of the *Ursus Spelæus*), a kidney shaped piece of hydrated geodic iron, analogous to a specimen of the same nature which I procured from the excavation of a dolmen at Birochère, near Pornic; the same bed likewise contained a substance which I think should be attributed to the peroxyde of manganese. Two analogous specimens came from the Devil's Furnace at Bourdeilles (the stratum of the Reindeer). Lastly, the hearthstone of Laugerie, parish of Tayac, has made me the possessor of a little mass of copper, almost completely covered with a coating of a green carbonate of copper, and cubic crystals of protoxide of copper. The aspect of this mineral, which, however, I think natural, is analogous to that of the Roman-French *fibulæ* in bronze, enclosing in a cavity similar crystals of oxydized copper. Beyond all doubt the primitive tribes had foreign relations, as is established by the remains of sea-shells found among wrought articles; at Bourdeilles the *Patella* and *Dentalium;* at Montgaudier, the *Buccinum* and *Dentalium*; at Eyzies, the *Cassis.* In the same way M. Lartet had discovered at Aurignac certain perforated disks, fashioned from the valves of the Cardium. Similar disks, taken out of the excavation of a dolmen, four miles from Mende, form part of my collection.

I do not wish to conclude this note without mentioning the presence of splinters of glass quartz among the flint instruments accompanying wrought bones. I collected the first specimen in the lower structure of the caves of Arcy (1862). The same fact is reproduced in 1863 at Montgaudier, and still later at Eyzies. This last fragment of rock crystal, slightly smoked, seems retouched at the edges.

To add a new fact to my own observations, I shall mention the interesting researches of two generations of Savants. While exploring the banks of the Charente, Messrs. de Rochebrune, father and son, succeeded in rescuing from the vandalism of the workmen some magnificent molars of the *Elephas Antiquus,* accompanied by molars of the *Elephas Primigenius,* a remarkable fragment of a tusk, and some bones of the limbs, unfortunately too few. Upon one of these last the most evident trace of an incision was recognizable. Among the rolled pebbles and the remains of crystalline rocks accompanying these bones,

* The tribes who undoubtedly bored the horns of the reindeer, the incisors of the horse and ox, the canines of the wolf, the reindeer, the *Ursus Arctos,* and the *Ursus Spelæus,* in order to suspend them by way of ornament or amulet, might equally well attribute to the metals some healing, or even supernatural, virtue.

I have established the fact of the presence of a flint instrument, characterised by workmanship of considerable finish.

To sum up: three principal facts are at the present day registered and grouped together, as the fruits of long and persevering researches, carried on by a great number of observers. The man of the earliest ages reveals himself by his works; man is associated by his relics with extinct races; lastly, man makes himself the revealer of his own existence by himself reproducing his own image.

For a long time people pretended to deny the presence of human skill in the rude efforts of the first stone instruments; at a later date they were forced to disparage the value of the intentional fractures and incisions observed in so large a number of bones belonging to the horse, the ox, or the reindeer. But now the bones are turned into numerous instruments; animal figures are found reproduced from the spoil of themselves; the living reindeer has served as a model for the carving of a dagger handle stuck fast in an osseous breccia. Nay, still further, the statuary of the first ages has reproduced the human species in a sort of lewd idol, the material of which belongs to the skeleton of the elephant.

I have attempted to retrace here the most conclusive facts; to my eyes the decision is manifest. I wish to propose one last question which I shadowed forth before. Should we separate the epoch of the reindeer, which I take here as the type of the migration of species, from the fauna of extinct races, with which on the other hand the reindeer is now found associated? In the double hypothesis of the association or the superposition of the fauna, man is revealed by his presence or by his work. The future is not far distant which shall teach us the more or less intimate correlation of these two stages. It is to my mind the only really serious difficulty which at the present day surrounds this interesting question.

T. M.

ON THE PERMEABILITY OF HIGHLY-HEATED IRON BY GASES.

Translated from the 'Comptes Rendus,' Feb. 15th, 1864.

NOTE, BY M. L. CAILLETET.

In a late communication to the Academy, MM. Sainte Claire and Troost made known the very curious phenomenon that iron at a high temperature is permeable by oxygen. It will also be remembered, that an iron tube, filled with

hydrogen and heated in a furnace, permits this gas to escape so thoroughly as to produce an almost perfect vacuum in the interior of the tube. These curious experiments will serve to explain many phenomena which present themselves in metallurgic operations, and which have never yet, I think, received satisfactory explanation. I have the honour to submit to the Academy the result of some researches I have made in this subject, and which it is my design to carry on and complete.

I caused some lengths of gun-barrels to be rolled flat, and then soldered the two ends, so that I thus obtained long rectangles formed of two plates in contact, soldered at the edges. On heating a lamina thus prepared to the high temperature of a smelting furnace, it was soon observed that the portions not soldered began to separate, and regained their cylindrical shape and original volume. This could doubtless only have been caused by the gases of the furnace penetrating the mass of iron, and producing the distension of the portions at first in contact. To this penetration of the gases we may attribute the blisters which frequently cover large pieces of cast-metal, especially those used for blinding, at the instant when they are extracted from the welding furnace. If one of these blisters is pierced on withdrawing the piece rough from the furnace, a jet of combustible gas is seen to escape, having been doubtless accumulated during the heating, in the cavities that occur in a piece which has been incompletely wrought.

It has been long observed that iron heated with coal-dust in the cementing-boxes, was covered, after its change to steel, with a quantity of bubbles, more or less numerous according to the nature of the metal employed, and it is easy to convince ourselves, by examination, that each of these bubbles corresponds to a point where the junction of the metallic sponge has been imperfect, whether owing to the presence of some infusible matter, as lime or the ash of the combustible used, or to the imperfection of the mechanical working. We may therefore suppose, after the experiments of Messrs. H. Deville and Troost, that the gases contained in the cementing-boxes traverse the pores of the iron, and accumulating in hollows of the red-hot metal, form the bubbles of which we are speaking. A rather simple experiment confirms this hypothesis. In fusing together the iron-plates which commonly occur in commerce, and are not of uniform texture, we always obtain the *poule* steel (as the steel covered with blisters is called); whereas if we work with the perfectly homogeneous iron, which is obtained by exposing cast-steel for many hours to a high temperature, it is then seen that the plates of this homogeneous iron return to the condition of steel, but without a single blister on their surface.

We may conclude from these experiments, that in order to procure steel with a smooth surface, we should employ iron as homogeneous as possible, and have recourse to a rapid process of cementation. Also, to avoid in castings the production of blisters, it is necessary to prevent the formation of hollows in the rough material, for, as we have tried to demonstrate, these blisters are caused by the gases of the furnace condensing in the cavities of the metal.

Remarks on the preceding by M. H. SAINTE-CLAIRE DEVILLE.

I have nothing to add to the very interesting and conclusive note of M. Cailletet. I wish merely to call his attention to another phenomenon which is frequently observed in metallurgic operations, namely, the disengagement at a high temperature of gases held in solution by liquids. The ebullition of silver and of litharge, so thoroughly investigated by M. Le Blanc, and the disengagement of bubbles of inflammable gas from the interior of vitreous masses, are phenomena which can be generalised with certainty. White iron and steel, at the moment of cooling, allow the escape of a gas (doubtless carbonic oxyde or hydrogen) which is highly injurious to the perfection of pieces run into cast-steel; and with this phenomenon we may connect some very curious observations of Messrs. Résal and Minari, on the production of scoriæ caused by bubbles of inflammable gas on the surface of white iron in fusion (or rather in the process of solidification), while it is very curious that the grey iron has nothing of the kind. It is easy to trace the origin of these combustible gases to the heating furnace, the walls of the crucibles permitting the surrounding gases by endosmose to concentrate upon the included materials. It would be very desirable that experiments should be made in the large metallurgic establishments where engineers have at their disposal scientific instruments, which become more precious in proportion as they know how to avail themselves of them, as M. Cailletet has well shown.

The experiment of M. Cailletet, combined with that which M. Troost and myself have published on the porosity of platinum, explains the formation of bubbles which often injure the quality of that metal, for these bubbles are formed only when platinum in plates is raised to a high temperature, and their development does not depend on the expansion of the air which we might suppose interposed between the metallic leaves which form the boundaries.

Note on the preceding communications, by M. CH. SAINTE-CLAIRE DEVILLE.

The curious experiment of M. Cailletet, as well as those recorded in the memoirs presented recently to the Academy by my brother and M. Troost, prove incontestably that the metals, platinum and iron, possess the property of permeability by gases when raised to bright incandesence. On the other hand, the researches of the two last-named philosophers prove that, while hydrogen traverses easily a tube of porcelain highly heated but not modified in structure, this is no longer the case when the temperature of the tube is raised to the point capable of softening or vitrifying its exterior wall. In this case, not only does the gas cease to traverse the tube, but it is stopped and partly absorbed by the vitrified surface, which again sets it free on recovering its porous structure. These different facts are connected with the antagonistic properties which distinguish the crystalline from the vitreous or amorphous condition. I have discussed the subject several times since the year 1845, and propose shortly to recur to it with some detail, attaching it to the more general fact of allotropy, of which it is only a particular case. At present I desire merely to call attention to the geological interest of the question, following out the train of reflection my brother has presented, and remarking some complimentary expressions to myself with which he has accompanied his last communication.

The oldest fact known of gas held in solution by substances in a state of igneous fusion, is that which occurs in the ebullition of silver. The similar phenomena which litharge gives at the instant of melting, were explained in the same way by M. Thenard; and the admirable researches of M. Félix Le Blanc, left no doubt in this respect. Lastly, the curious experiments which my brother brought forward at the meeting on Dec. 14, give a most direct proof that vitreous bodies in fusion possess the property of absorbing and of subsequently disengaging gaseous substances, obtained from the surrounding medium; and in that case, the gas was of a combustible nature. It was natural, and long ago it occurred to me, to connect with this singular property of lithoid substances in fusion many facts which have been observed in recent lavas and volcanic eruptions. The lavas which issue from volcanoes form two distinct varieties, from our present point of view. The first, being rich in silica and very readily fusible, easily assume the vitreous condition on cooling, and then form obsidian; the others, which are of more common occurrence (dolerites, amphigenites, basalts) contain generally not more than 50 per cent. of silica, and most of them are rich in lime. To fix our ideas by an example, the neighbourhood of Naples presents both these varieties of rocks,—the old trachytes and the pumiceous tufas of the Phlegrœan plains on the one hand, and the amphigenitic masses of the Somme and Vesuvius on the other. The lavas of the volcano, whatever may have been their rate of cooling, are always crystalline, with some very rare exceptions of very small extent, which are subvitreous or imperfectly crystalline. The volatile matters, such as steam, metallic chlorides, hydro-sulphuric acid, &c., which they contain, and which must have been dissolved in the highly-heated medium where they were fused, disengage themselves successively in the order I have explained, in proportion as the interior work of crystallisation went slowly on; precisely as at the instant of the ebullition of silver there is an escape of oxygen, or, as in another class of phenomena, the air held in solution in water is separated from it at the instant of freezing. The act of crystallising causing a large and sudden increase of density, there results at that instant a corresponding disengagement of latent heat, and I do not hesitate to assign to this cause the subsequent heating of the lava of 1855, observed by M. Scacchi, and verified by M. Albert Gaudry and myself. Similar facts did not escape older observers, for Serrao, after having proved the occurrence of this in the lava of 1737, remarks, that "the lavas must contain within themselves some cause which develops heat, and brings them back to incandescence when they have been already completely cooled (on the surface)."

The flames which have been often observed in Vesuvius, and in particular by Leopoldo Pilla, could be attributed only to the combustion of gases given out during the eruption; but, at the last eruption of December, 1861, I was fortunate enough to put beyond doubt the fact that combustible gases are disengaged from the incandescent lava in the act of cooling, and the exact analyses made on my return, by MM. Le Blanc, Fouqué, and myself, have proved that they consisted of a mixture of light carburetted hydrogen and hydrogen. It is then natural to admit that the incandescent matter was surrounded, in the furnace from which it proceeds, by an atmosphere of this nature, that it became impregnated with it while in a liquid state, and again set it free in its progressive passage to

the crystalline condition. The subsequent heating which I have mentioned in the gases escaping from the lava is doubtless also an indication of the heat rendered sensible by the act of crystallising.

When the eruptive matter, instead of having, like the lavas above spoken of, a great tendency to crystallise, offers on the contrary, along with an excess of silica, a tendency to solidify in the vitreous form, it constitutes obsidian. It then imprisons and solidifies in some way the volatile substances held in solution by it, and at the same time it retains a certain quantity of latent heat (which I propose to call the *latent heat of fusion*) which gives it a minimum of density; But it is remarkable, that if we proceed to heat this obsidian nearly up to its melting point, it puffs up so that its volume increases enormously; and yet, this extreme porosity of substance, rendering it everywhere of excessive friability, and, as it were, papyraceous in texture, corresponds only to an insignificant loss—some thousandths—of its original weight. When thus once transformed into pumice, it requires a very intense heat to soften it anew and melt it. Is it not natural to suppose that the temperature to which the obsidian was at first subjected, and which was relatively low, has only brought this glass to a particular molecular state, which by permitting the stored-up heat to be disengaged, has furnished the rest of the supply of caloric necessary to resoften the substance and facilitate the expulsion of the gases? Just as in the well-known experiment of M. Regnault, the soft sulphur (that is, the vitreous sulphur, the obsidian of sulphur) when raised to 92 or 93 degrees, suddenly sets free a certain quantity of heat, and raises the temperature of the thermometer in contact with it to 110°.

However this may be, let us revert to the Phlegræan plains which surround Vesuvius. We shall find them to consist entirely of trachytes, obsidian, and pumice, all which are beyond compare vitreous or vitrifiable substances. We may therefore conceive that a relatively small elevation of temperature, much inferior to that observed at each eruption of Vesuvius, on being applied in the interior of the soil to the masses of obsidian, changes them into pumice, with a large increase of volume; and from this there would result an immense force which, breaking the overlying crust, would lift it up in a bubble-shaped heap, projecting its fragments in all directions. Thus would be accounted for, as I have already remarked, both the facts observed at Monte Nuovo in 1538, and the production of the numerous craters of the Campagna.

Lastly (and I need not say that I offer this conjecture with reserve), if we notice the resemblance that exists between the map of the Phlegrœan plains and that of the moon's surface, it is natural enough to believe that this latter owes its form to action of the same nature, and it may not perhaps be inappropriate to remark that a globe composed entirely of vitrified matter may thus have condensed and retained in solution within its own mass the gaseous elements which originally surrounded it, and which , but for this circumstance, would have constituted an atmosphere for it. And in applying this conception to our own globe, is it not conceivable that the primitive granitic crust, essentially rich in silica (a substance of which I have proved the extreme fusibility) had condensed before its solidification, a portion at least of the gases which form our atmos-

phere? On this hypothesis, watery vapor, hydrogen, carburetted and sulphuretted hydrogen (these last three bodies oxidising on coming to the surface) would be only the last remains of this atmosphere stored up by the rocks in fusion; just as the metallic fluorids, chlorids, and sulphurs, which still constitute our lavas, are only, according to the beautiful researches of M. Elie de Beaumont, the last representatives of the substances which have been successively disengaged from the eruptive rocks in forming the concreted veins.

J. B. C.

ENTOMOLOGICAL SOCIETY OF CANADA.

The second annual meeting of the society was held in the Council Room of the Canadian Institute, on Tuesday, May 14th, at 3 o'clock P.M., the President, Prof. Croft, in the chair.

The minutes of the previous meeting were read and confirmed.

Communications were read

From the Rev. Vincent Clementi of Peterborough, expressing regret at his inability to attend the meeting.

From Geo. Jno. Bowles, Esq., and others, on the establishment of a branch of the Society in Quebec.

W. E. Milward, Esq., M.D., of Grimsby, was proposed, and elected a member.

The committee on Lepidoptera reported the publication of a catalogue of all the known Canadian Butterflies and Sphinxes; copies of this catalogue will be forwarded to members immediately.

The committee on Coleoptera reported that considerable progress had been made in the determination of species, etc., though not sufficient to warrant the publication of a catalogue as yet.

The curator reported that the resolution passed at a previous meeting relative to the apparatus required in collecting and preserving insects, had been acted upon, and that sheet cork, entomological pins, etc., can now be had through the Society at cost prices.

Objections having been raised to the English pins, Dr. Morris and Mr. Hubbert were requested to secure 50,000 German pins as early as possible.

The following donations were announced, and the thanks of the Society cordially tendered to the donors:

From the Entomological Society of Philadelphia—

185 Specimens, including 135 species of Coleoptera.
25 " " 20 " Set.

From Dr. Thomas Cowdry, and H. Cowdry, Esq., York Mills—

135 Specimens, including 65 species of Coleoptera.
3 " " 3 " Diptera.
4 " " 3 " Hemiptera.

From W. Saunders, Esq., collected by G. J. Bowles, Esq., Quebec—

54	Specimens,	including	16	species of Coleoptera.
8	"	"	6	" Lepidoptera.

From W. Saunders, Esq., collected at London—

15	Specimens,	including	11	species of Coleoptera.
9	"	"	3	" Lepidoptera.
1	"	"	1	" Diptera.

From James Hubbert, Esq., M.A., Toronto—

240	Specimens,	including	87	species of Coleoptera.
39	"	"	26	" Lepidoptera.
19	"	"	13	" Diptera.
22	"	"	9	" Hymenoptera.
14	"	"	5	" Neuroptera.

From W. Turton, Esq., London—

18 Specimens, including 9 species of Lepidoptera.

From the Rev. W. F. Clarke, Toronto—

4	Specimens,	including	4	species of Canadian Lepidoptera.
7	"	"	6	" Hymenoptera.
1	"	"	1	" Neuroptera.
1	"	"	1	" Hemiptera.

Also the following, many of which were insects of considerable interest.

8	Specimens,	including	5	species of Chinese Coleoptera.
1	"	"	1	" Diptera.
3	"	"	2	" Orthoptera.
1	"	"	1	" Hemiptera.
1	"	"	1	" Lepidoptera.

Mr. Sanderson moved, seconded by Mr. Reed, that a committee consisting of the following members be appointed to draft a constitution, and to report thereon at the next meeting—Prof. Croft, Prof. Hincks, Dr. Morris, and Mr. Hubbert.—Carried.

Moved by Dr. Morris, seconded by Prof. Hincks, that it is desirable to establish a class of corresponding members.—Carried.

Moved by Mr. Hubbert, seconded by Mr. Saunders, that the office of Vice-President be added to those already existing in the Society.—Carried.

Moved by Mr. Saunders, seconded by Prof. Hincks, that the action 'of Prof. Croft and Dr. Morris in reference to the Quebec branch be sustained.—

The following officers were then elected for the ensuing year:

President,	Wm. Saunders, Esq.
Vice-President,	Rev. Wm. Hincks, F.L.S.
Secretary-Treasurer,	Rev. Chas. J. S. Bethune, M.A.
Curator,	James Hubbert, Esq., M.A.

During the absence of Mr. Bethune in Britain, Mr. Hubbert was appointed Secretary-Treasurer *pro. tem.*

The following Members were appointed on the standing Committees for the Insect Classes, etc.:

On Coleoptera—Mr. Billings, Prof. Croft, and Mr. Saunders.

On Lepidoptera—Dr. Morris, Mr. Bethune, and Mr. Reed.

On Orthoptera and Neuroptera—Prof. Hincks, Mr. Billings, and Dr. Cowdry.

On Diptera—Mr. Hubbert, Mr. Rogers, Mr. Billings.

On Hymenoptera—Mr Saunders, Mr. Hubbert, Mr. Becket.

On Insect Architecture—Mr. Couper, Mr. Hubbert, Dr. Sangster.

These Committees to pay special attention to the insects injurious to vegetation, and to the works of man. Reports to be presented at the next annual meeting of the society.

A committee, on the silk-producing moths of Canada, was also appointed, with instructions to collect information, make observations, and, if possible, conduct experiments on the different species of Attacus, &c., and the possibility of utilizing their silk. The committee to consist of Prof. Croft, Mr. Hubbert, and Mr. Saunders. Reports to be given in at the next annual meeting, or earlier, if convenient. The attention of the members was called to the *Canada Farmer*, as a suitable medium for collecting and circulating information on the insect tribes, either injurious or beneficial to man, their habits, and the best means of counteracting and preventing the ravages of destructive species.

Donations of insects were voted to the Quebec Branch, and to the museum of University College, Toronto.

Prof. Croft drew the attention of the members to some pecularities in the flight of Deiopéia bella, and to the ravages during the past summer of Clytus flexuosus, many of the acacia trees of Toronto, and the vicinity, having fallen victims to the boring of the larvae.

Dr. Morris exhibited and made some remarks on a rare Curculio (Hylobius) pinicola, from Quebec.

Mr, Saunders exhibited specimens of Cyanobius bella, and a rare Hesperia, presented by Dr. Scudder, of Cambridge, Mass.

The following Papers were laid before the Society.

On the structure and habits of Gastropacha velleda, by Prof. Croft.

On insect phenomena observed in Peterborough and the vicinity, by the Rev. V. Clementi, B.A.

Observations among the Lepidoptera, during the summer of 1863, by W. Saunders, Esq.

On the geographical distribution of the Dipterous faunas of Europe and North America, with the causes which influence it, by Jas. Hubbert, Esq., M.A.

The meeting then adjourned.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—APRIL, 1864.

Latitude—43 *deg.* 39.4 *min. North.* *Longitude*—5 *h.* 17 *min.* 33 *sec. West.* *Elevation above Lake Ontario,* 108 *feet.*

Day.	Barom. at temp. of 32°. 6 A.M.	2 P.M.	10 P.M.	MEAN.	Temp. of the Air. 6 A.M.	2 P.M.	10 PM	ME'N	Excess of mean above Normal.	Tens. of Vapour. 6 A.M.	2 P.M.	10 P.M.	M'N
					°	°	°	°	°				
1	29.431	29.390	29.358	29.3873	32.7	37.6	36.0	35.40	— 0.83	.180	.185	.196	.189
2	.320	.344	.456	.3812	35.4	41.7	39.6	39.00	+ 2.37	.205	.192	.219	.204
3	.549	.619	—	—	37.4	43.9	—	—	—	.213	.209	—	—
4	.609	.545	.492	.5435	36.7	43.5	39.6	40.42	+ 3.08	.197	.168	.176	.190
5	.526	.583	.656	.5952	36.0	37.8	37.8	37.35	— 0.37	.189	.165	.183	.178
6	.736	.810	.880	.8197	36.3	45.0	40.3	40.17	+ 2.13	.202	.239	.228	.220
7	.902	.858	.798	.8443	39.6	45.7	41.0	42.53	+ 4.12	.219	.221	.200	.214
8	.776	.686	.613	.6890	41.0	49.0	46.1	45.18	+ 6.47	.227	.256	.161	.220
9	.512	.497	.428	.4658	39.2	41.0	39.9	39.83	+ 0.80	.180	.246	.233	.218
10	.338	.322	—	—	34.5	36.0	—	—	—	.192	.196	—	—
11	.488	.535	.606	.5487	36.3	44.6	39.9	41.07	+ 1.33	.202	.208	.233	.214
12	.589	.541	.504	.5435	35.3	36.7	36.3	36.57	— 3.57	.181	.163	.185	.176
13	.414	.455	.503	.4622	33.4	39.2	35.3	36.45	— 3.98	.171	.199	.189	.187
14	.526	.574	.592	.5670	35.6	43.5	39.6	39.38	— 1.35	.193	.194	.194	.196
15	.534	.440	.379	.4430	36.7	46.4	37.8	40.60	— 0.45	.179	.195	.157	.169
16	.350	.313	.363	.3447	32.0	44.6	37.4	39.32	— 2.17	.143	.191	.119	.161
17	.385	.409	—	—	31.6	47.2	—	—	—	.140	.175	—	—
18	.539	.569	.665	.5972	32.7	47.3	35.6	39.00	— 3.07	.135	.155	.142	.142
19	.708	.734	.710	.7143	36.0	43.3	40.7	40.82	— 1.53	.172	.162	.161	.168
20	.666	.611	.615	.6277	36.7	44.3	38.9	41.52	— 1.27	.172	.140	.151	.166
21	.654	.677	.727	.6888	35.2	53.6	38.9	43.25	+ 0.15	.147	.155	.168	.150
22	.779	.667	.593	.6685	34.5	53.3	45.7	45.77	+ 2.40	.163	.178	.268	.207
23	.577	.586	.697	.6295	49.3	48.6	41.4	46.18	+ 2.48	.332	.312	.250	.286
24	.785	.747	—	—	38.5	42.8	—	—	—	.208	.223	—	—
25	.444	.447	.483	.4527	47.2	45.7	40.3	44.82	+ 0.42	.240	.288	.236	.266
26	.487	.473	.521	.4953	41.0	54.4	49.3	49.25	+ 4.55	.246	.298	.293	.278
27	.542	.575	.793	.6490	42.1	41.0	33.4	37.77	— 7.25	.232	.184	.112	.169
28	.821	.834	.939	.8668	29.5	45.0	38.8	38.30	— 7.10	.121	.158	.160	.153
29	.938	.878	.851	.8835	35.6	47.2	40.3	41.43	— 4.30	.142	.128	.158	.135
30	.754	.609	.512	.6083	38.1	46.4	42.5	43.43	— 2.62	.187	.130	.244	.183
...	...	...	...	...	...	...	...	...	...	...	...	...	...
M	29.6008	29.5858	29.6052	29.5968	37.08	44.86	39.71	40.95	— 0.04	.191	.196	.193	.194

Day.	Humidity of Air. 6 A.M.	2 P.M.	10 P.M.	M'N	Direction of Wind. 6 A.M.	2 P.M.	10 P.M.	Resultant Direction.	Velocity of Wind. 6 A.M.	2 P.M.	10 PM	Resul't.	ME'N	Rain in Inches.	Snow in Inches.
								°							
1	.97	.82	.93	.92	E N E	E b N	E N E	N 81 E	2.0	8.5	10.0	7.92	8.04	...	...
2	.99	.72	.90	.86	E b N	E N E	N E	N 65 E	8.5	11.8	3.6	6.92	7.57	0.045	...
3	.95	.72	—	—	N b W	S E b S	S E b S	N 86 E	5.4	5.5	4.0	2.96	4.71	Inp.	...
4	.90	.59	.72	.76	E b N	E b N	E b S	N 84 E	9.8	16.8	8.0	10.95	11.23	0.100	...
5	.89	.72	.80	.80	E S E	E	E N E	N 81 E	9.0	12.2	5.8	7.35	7.63	0.015	...
6	.94	.80	.91	.88	N E b E	E S E	Calm.	N 87 E	4.8	3.8	0.0	1.10	1.22	0.005	...
7	.90	.72	.78	.79	Calm.	E b S	N E b E	N 89 E	0.0	9.0	1.5	3.32	3.50	...	...
8	.88	.74	.51	.73	N E b E	E	E N E	N 76 E	2.2	8.6	14.8	9.97	10.21	...	...
9	.75	.96	.95	.89	E b N	E	E	N 86 E	12.6	14.8	17.0	16.51	16.57	1.280	...
10	.96	.93	—	—	E b N	E b N	E b N	N 81 E	22.0	13.5	10.0	10.74	10.84	0.160	1.0
11	.94	.70	.95	.84	E b N	W N W	N b W	N 23 W	1.5	7.8	7.0	1.51	3.23	Inp.	...
12	.88	.75	.86	.81	N E	E N E	E N E	N 72 E	6.0	12.0	18.5	11.25	11.37	Inp.	1.0
13	.89	.83	.92	.87	N E	N W	W b S	N 48 W	7.0	11.8	3.4	5.85	6.89	Inp.	1.5
14	.93	.68	.79	.81	N W	S	S W	N 62 W	6.8	3.8	1.5	2.62	4.77	0.033	...
15	.82	.61	.69	.67	N W b N	S S W	S W b S	N 60 W	5.0	8.6	5.2	0.20	5.19	...	...
16	.79	.65	.53	.66	E	S b W	N N W	N 21 W	0.5	6.2	10.2	3.37	8.42	...	...
17	.78	.52	—	—	N N W	W	W b N	N 59 W	6.5	19.2	7.0	12.98	13.12	...	...
18	.73	.47	.68	.61	N W	S S W	N	N 18 W	9.2	3.0	9.2	5.79	8.06	...	...
19	.81	.58	.62	.66	N	S S W	W N W	N 7 E	4.0	1.0	4.2	2.77	4.96	...	...
20	.78	.47	.63	.62	N b W	S b E	N	N 49 W	7.0	3.8	0.5	1.31	4.01	...	...
21	.72	.36	.70	.56	Calm.	S S W	Calm.	S 17 W	0.0	10.0	0.0	2.22	3.83	...	...
22	.82	.43	.87	.69	Calm.	E	S b E	S 64 E	0.0	11.8	3.0	3.49	5.91	0.175	...
23	.94	.91	.96	.91	S W b S	N N W	N W b N	N 14 W	3.5	9.6	6.0	5.07	5.42	1.010	...
24	.89	.81	—	—	N W b N	E	E b N	N 75 E	5.0	12.5	17.5	14.73	14.95	...	...
25	.73	.94	.95	.89	N E b N	S W b S	Calm.	N 69 E	14.8	1.0	0.0	2.07	2.99	0.490	...
26	.95	.69	.83	.80	N W b N	S W b S	N W	N 67 W	2.5	3.2	13.5	7.89	9.34	...	...
27	.86	.71	.58	.71	N b W	N W b N	N N W	N 28 W	9.0	30.5	18.0	18.46	18.52	0.215	...
28	.74	.51	.68	.66	N N W	N	E N E	N 11 W	15.5	16.8	0.5	9.42	9.77	...	...
29	.68	.38	.63	.52	N b W	S	W S W	S 1 W	6.0	8.5	3.5	1.22	5.15	...	...
30	.81	.41	.89	.66	N b W	E N E	N N W	N 36 E	1.5	11.5	2.2	3.49	5.58	0.105	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
M	.85	.66	.78	.75	....	....	....	....	6.25	9.90	6.85	....	7.77	3.633	3.5

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR APRIL, 1864.

NOTE.—The monthly means do not include Sunday observations. The daily means, excepting those that relate to the wind, are derived from six observations daily, namely at 6 A.M., 8 A.M., 2, 4 and 10 P.M., and midnight. The means and resultants for the wind are from hourly observations.

Highest Barometer........................29.964 at 8 a.m. on 29th } Monthly range =
Lowest Barometer ....29.301 at 4 p. m. on 16th } 0.663 inches.

Self-registering Thermom.
- Maximum Temperature ....59°4 on p.m. of 26th } Monthly range=
- Minimum Temperature ....28°1 on a.m. of 28th } 31°3
- Mean maximum Temperature .... 47°48 } Mean daily range=
- Mean minimum Temperature .... 34°61 } 12°87
- Greatest daily range ......24°4 from a.m. to p.m. of 21st.
- Least daily range............ 5°2 from a.m. to p.m. of 10th.

Warmest day ....26th... Mean temperature.......... 49°25 } Difference = 13°85.
Coldest day .... 1st... Mean temperature .... 35°40 }
Maximum { Solar................................. 101°5 on p.m. of 26th } Monthly range =
Radiation. { Terrestrial......................... 20°0 on a.m. of 17th } 81°5
Aurora observed on 4 night, viz.,—on 7th, 24th, 27th and 29th.
Possible to see Aurora on 10 nights; impossible on 20 nights.
Snowing on 3 days, depth 3.5 inches; duration of fall, 10.0 hours.
Raining on 16 days, depth 3.633 inches; duration of fall 78.6 hours.
Mean of cloudiness = 0.74; above average 0.15.
Most cloudy hour observed, 4 p.m; mean = 0.79; least cloudy hour observed, 8 a.m.; mean, = 0.68.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
2354.18	503.01	2812.96	1217.19

Resultant direction N. 41° E.; Resultant velocity 3.39 miles per hour.
Mean velocity ....7.77 miles per hour.
Maximum velocity .... 33.0 miles, from 3 to 4 p.m. on 27th.
Most windy day ......27th...........Mean velocity, 18.52 miles per hour. } Difference=
Least windy day ... 6th.............Mean velocity, 1.22 ditto } 17.30 miles.
Most windy hour ... 11 a.m to noon.........Mean velocity, 10.55 ditto. } Difference=
Least windy hour ...2 a.m. to 3 a.m..........Mean velocity, 5.74 ditto. } 4.81 miles.

1st. Dense fog 6 and 8 a.m., gloomy and mild.—2nd. Dense fog 6 and 8 a.m., dark and mild.—4th.—Solar halo from noon to 2 p.m., dark and mild.—7th. Fog 6 and 8 a.m.; faint auroral light at 10 p.m.—8th. Solar halo at 1 p.m.; sheet lightning in S.W. at 9 and 10 p.m.—10th. Rain and snow intermixed 6 to 11 a.m.—11th. Fog 6 and 8 a.m.—12th. Fog at 6 a.m.—14th. Well defined rainbow 6 p.m.—17th. Solar halo at 6 a.m.—20th. Lunar halo at midnight.—21st. Lunar corona at midnight. —22nd. Solar halo 1 p.m.—23rd. Fog 6 and 8 a.m.—24th. Solar halo 4 p.m., and auroral light at 9 p.m.—25th. Dense fog 10 p.m. and midnight.—26th. Fog 6 a.m.

April, 1864, was very rainy, and the snow being also above the mean, the precipitation was greater than the average; mean temperature just equalled the average of 25 years.

COMPARATIVE TABLE FOR APRIL.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above aver'ge (26.1)	Max. ob-served.	Min. ob-served.	Range.	No. of days.	Inches	No. of days.	Inches	Resultant. Direction.	Resultant. V'y.	Mean Force or Velocity.
	°	°	°	°	°							
1840	42.4	+ 1.4	65.9	25.3	40.6	14	3.420	2	...	...	...	....
1841	39.2	— 1.8	62.9	22.1	40.8	3	1.370	3	...	...	...	0.51lbs.
1842	43.1	+ 2.1	89.5	21.6	67.9	8	3.740	2	...	...	...	0.57
1843	40.9	— 0.1	70.0	15.1	54.9	7	3.185	3	...	...	...	0.46
1844	47.5	+ 6.5	74.5	17.2	57.3	10	1.515	1	Inap.	...	...	0.24
1845	42.1	+ 1.1	66.0	14.8	51.2	11	3.290	4	1.5	...	...	1.00
1846	44.0	+ 3.0	79.4	24.4	55.0	10	1.300	2	1.3	...	...	0.55
1847	39.2	— 1.8	65.6	8.4	57.2	8	2.870	2	4.0	...	...	0.59
1848	41.3	+ 0.3	65.4	26.5	38.9	5	1.455	1	0.5	N 77° W	1.46	4.89mls.
1849	39.0	— 2.0	70.9	23.2	47.7	10	2.655	2	1.7	N 43° W	3.14	7.50
1850	37.9	— 3.1	63.2	18.2	45.0	7	4.720	2	1.1	N 39° W	1.12	7.64
1851	41.3	+ 0.3	59.2	25.8	33.4	11	2.295	5	1.2	N 14° E	2.52	8.07
1852	38.2	— 2.8	53.8	19.8	34.0	6	1.990	4	9.4	N 23° E	2.44	6.68
1853	41.9	+ 0.9	65.7	27.0	38.7	10	2.625	1	1.0	N 12° W	1.95	5.20
1854	41.0	0.0	65.1	22.3	42.8	12	2.685	4	2.7	N 50 E	2.57	6.81
1855	42.4	+ 1.4	63.8	12.2	51.6	8	2.030	3	1.6	N 36° W	3.99	7.57
1856	42.3	+ 1.3	69.8	15.1	54.7	13	2.780	3	0.1	N 29° E	1.64	6.05
1857	35.4	— 5.6	51.9	10.0	41.9	10	1.755	11	12.9	N 60° W	4.15	10.24
1858	41.5	+ 0.5	61.5	23.8	37.7	13	1.642	2	0.1	N 14° W	1.64	9.57
1859	39.5	— 1.5	62.1	23.9	38.2	9	2.527	8	1.2	N 36° W	2.33	10.79
1860	39.5	— 1.5	60.7	19.7	41.0	11	1.282	5	0.3	N 37° W	4.10	10.80
1861	42.0	+ 1.0	62.3	26.2	36.1	12	1.619	4	6.9	N 37° E	2.31	8.90
1862	39.6	— 1.4	64.1	20.1	44.0	10	2.235	4	0.2	N 50° E	2.48	9.77
1863	42.0	+ 1.0	67.7	8.9	58.8	8	2.210	4	1.6	N 14° E	3.75	9.20
1864	40.9	— 0.1	58.3	29.5	28.8	16	3.633	3	3.5	N 41° E	3.39	7.77
Results to 1864.	40.96	...	65.57	20.04	45.53	9.7	2.433	3.3	2.40	N 7° W	2.07	8.06
Exc. for 1864.	— 0.01	...	— 7.27	+ 9.46	— 16.73	+ 6.3	+ 1.200	— 0.3	+ 1.10	....	... ..	— 0.29

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—MAY, 1864.

Latitude—43 *deg.* 39.4 *min. North.* *Longitude*—5 *h.* 17 *m.* 33 *s. West.* *Elevation above Lake Ontario,* 108 *feet.*

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resul't. Direction.	Velocity of Wind.					Rain in inches.	Snow in inches.
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M	2 P.M	10 P.M	ME'N		6 A.M.	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N	6 A. M.	2 P. M.	10 P. M.		6 A.M.	2 P.M.	10 P.M.	Re-sul't.	ME'N		
					°	°	°	°	°												°							
1	29.450	29.239	—	—	40.3	53.6	—	—	—	.236	.227	—	—	.95	.54	—	—	W b N	S W b W	N W b W	S 78 W	3.0	7.0	0.2	3.84	4.93	Inp.	...
2	.332	.166	29.197	29.2325	41.7	51.1	38.1	42.75	— 3.97	.218	.247	.213	.222	.82	.65	.93	.81	S W b W	E N E	W b S	N 11 W	1.0	17.0	8.2	3.34	7.65	0.310	...
3	.192	.280	.463	.3262	35.3	41.0	44.6	40.85	— 6.20	.189	.237	.245	.230	.92	.92	.83	.89	E b N	S W b S	N W	N 43 W	5.5	6.5	16.0	4.92	6.93	.300	...
4	.609	.647	.708	.6628	41.0	61.6	45.0	49.68	+ 2.27	.218	.256	.221	.246	.85	.46	.74	.71	W b N	W b N	W S W	N 75 W	3.5	11.8	2.5	6.29	7.25	..	...
5	.771	.686	.611	.6862	44.3	62.3	55.8	54.43	+ 6.70	.230	.324	.280	.285	.79	.58	.62	.67	Calm.	S S W	S W	S 30 W	0.0	14.5	8.5	6.39	6.50	...	...
6	.554	.489	.658	.5707	51.8	66.3	48.6	55.93	+ 7.90	.310	.419	.292	.344	.80	.64	.85	.77	Calm.	S W b S	N b W	N 48 W	0.0	8.2	4.0	2.94	6.81	.090	...
7	.633	.541	.500	.5532	43.5	43.5	44.3	43.88	— 4.53	.259	.259	.278	.265	.92	.92	.95	.93	E b S	E N E	E	N 83 E	5.0	7.0	0.5	3 04	3.08	.200	...
8	.469	.401	—	—	43.5	56.2	—	—	—	.268	.406	—	—	.95	.90	—	—	E	E b S	Calm.	S 48 E	0.8	1.5	0.0	0.75	0.82	.258	...
9	.383	.296	.236	.2903	50.4	66.3	53.3	57.55	+ 8.38	.351	.407	.355	.383	.96	.62	.87	.81	Calm.	S W b S	Calm.	S 26 W	0.0	10.0	0.0	3.35	3.47	.225	...
10	.225	.315	.567	.3823	52.2	42.5	36.7	42.55	— 6.95	.381	.263	.155	.251	.97	.67	.71	.88	N E	N N W	N b W	N 18 W	6.5	22.0	6.0	11.94	12.20	.620	...
11	.616	.570	.555	.5747	36.3	39.2	40.7	39.58	—10.32	.157	.138	.204	.169	.74	.57	.80	.69	E N E	Calm.	E S E	N 75 E	6.5	0.0	1.2	1.80	1.93	...	...
12	.535	.523	.531	.5280	38.8	51.5	42.1	45.22	— 4.95	.195	.174	.223	.203	.82	.45	.83	.69	Calm.	S S E	E N E	S 40 E	0.0	2.5	3.5	1.79	2.85	.095	...
13	.528	.469	.457	.4833	44.3	54.0	52.6	50.47	— 0.10	.178	.379	.321	.328	.95	.91	.80	.89	N E b N	N b E	N	N 8 E	2.8	13.8	14.0	9.37	9.53	.445	...
14	.485	.499	.545	.5108	51.1	57.6	54.7	54.78	+ 3.90	.362	.446	.392	.396	.96	.94	.91	.92	N	E N E	E b N	N 69 E	9.0	16.5	12.2	10.13	10.57	.027	...
15	.591	.624	—	—	53.6	64.1	—	—	—	.373	.398	—	—	.91	.66	—	—	E b N	E N E	N E b N	N 66 E	12.4	12.5	7.0	9.14	9.34	.515	...
16	.627	.602	.486	.6055	56.9	66.6	60.9	61.10	+ 9.52	.431	.479	.441	.454	.93	.73	.82	.84	E	E b S	Calm.	N 80 E	9.5	6.8	0.0	3.43	3.64	Inp.	...
17	.556	.514	.507	.5252	61.2	69.5	65.6	66.03	+14.05	.446	.533	.453	.473	.83	.74	.71	.74	N N W	Calm.	E	N 17 E	1.8	0.0	0.8	2.30	3.75	...	...
18	.547	.536	.520	.5353	57.6	64.1	59.0	61.50	+ 9.22	.399	.291	.292	.333	.84	.48	.57	.61	N	S	N W b N	N 77 E	8.0	3.2	2.8	1.56	3.28	...	...
19	.568	.584	.556	.5700	54.7	65.2	55.4	59.05	+ 6.43	.263	.334	.295	.287	.60	.53	.67	.57	E E b E	S b W	Calm.	S 80 E	2.4	2.8	0.0	1.07	2.03	...	...
20	.562	.438	.352	.4432	52.2	67.0	60.9	60.82	+ 7.80	.305	.385	.438	384	.78	.58	.81	.72	N b E	S b W	W S W	S 89 W	1.0	8.4	3.2	4.21	5.81	...	...
21	.334	.275	.308	.3057	63.4	72.0	64.8	67.23	+13.92	.445	.500	.445	.468	.76	.63	.72	.70	N W b W	N W b N	N W	N 52 W	1.0	12.5	12.0	7.85	9.27	Inp.	...
22	.446	.534	—	—	56.2	65.9	—	—	—	.360	.290	—	—	.80	.45	—	—	N N W	N N W	S E b S	N 4 W	5.0	7.5	1.0	2.52	4.06	...	...
23	.536	.377	.322	.4017	49.0	59.4	54.0	55.00	+ 1.03	.297	.297	.325	.312	.85	.58	.78	.72	Calm.	E	E N E	N 84 E	0.0	9.8	1.2	3.67	4.11	...	...
24	.356	.346	.376	.3593	54.0	69.5	63.0	63.02	+ 8.73	.367	.532	.487	.470	.88	.74	.85	.81	S E b S	S b W	N E b N	S 39 W	1.5	8.0	4.2	1.55	5.48	.355	...
25	.372	.406	.430	.3987	59.8	65.5	56.2	60.80	+ 6.12	.492	.506	.417	.467	.96	.80	.93	.88	N N E	S E b S	Calm.	S 76 E	2.8	1.4	0.0	1.02	1.22	...	...
26	.406	.312	.274	.3225	58.7	64.1	63.4	61.70	+ 6.72	.467	.512	.444	.464	.95	.85	.76	.84	E N E	S E b S	N W b N	N 24 W	1.5	1.8	5.5	3.04	4.41	.010	...
27	.279	.346	.488	.3828	60.1	73.3	55.4	62.78	+ 7.50	.414	.252	.285	.300	.79	.30	.64	.54	N E b N	N W	N W b W	N 24 W	12.8	19.5	9.2	12.19	12.64	...	..
28	.630	.689	.718	.6848	48.6	56.5	45.7	50.57	— 5.08	.201	.175	.211	.193	.58	.38	.68	.53	N N W	N W b N	Calm.	N 22 W	14.8	15.5	0.0	8.91	9.36	...	...
29	.667	.495	—	—	46.8	49.7	—	—	—	.206	.328	—	—	.64	.91	—	—	Calm.	S b W	Calm.	S 32 W	0.0	9.5	0.0	3.82	4.18	.040	...
30	.495	.460	.334	.4335	51.5	60.1	54.4	54.97	— 1.28	.294	.366	.341	.327	.77	.70	.80	.75	N W b W	E b S	S W	S 80 E	2.5	7.0	1.3	3.20	3.96	...	...
31	.434	.486	597	.5053	60.5	73.8	55.5	62.90	+ 6.35	.408	.409	.404	.402	.77	.49	.92	.72	Calm.	S E	N	N 11 W	0.0	2.2	2.5	1.43	3.72	.580	...
M	29.4833	29.4558	29.4761	29.4721	50.73	60.13	52.72	54.81	+ 3.33	.322	.351	.325	.333	.84	.66	.79	.75	....	....	....	....	3.89	8.60	4.11	......	5.64	4.070	0.0

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR MAY, 1864.

NOTE.—The monthly means do not include Sunday observations. The daily means, excepting those that relate to the wind, are derived from six observations daily, namely, at 6 A.M., 8 A.M., 2 P.M., 4 P.M., 10 P.M., and midnight. The means and resultants for the wind are from hourly observations.

Highest Barometer . . . . 29.788 at 8 a.m. on 5th. } Monthly range=
Lowest Barometer . . . . 29.166 at 2 p.m. on 2nd. } 0.622 inches.

Self-registering Ther.:
- Maximum temperature . . . . 79°0 on p.m. of 21st } Monthly range=
- Minimum temperature . . . . 32°2 on a.m. of 11th } 46°8
- Mean maximum temperature . . 62°86 } Mean daily range=16°67
- Mean minimum temperature . . 46°20 }
- Greatest daily range . . . . . . 26°2 from a. m. to p. m. of 4th.
- Least daily range . . . . 6°2 from a. m. to p. m. of 7th.

Warmest day . . . 21st...Mean Temperature . . . 67°23 } Difference=27°65.
Coldest day . . . . 11th...Mean Temperature . . . 39°58 }
Maximum Radiation { Solar (Vacuum) . . . . 121°0 on p. m of 31st } Monthly range=
{ Terrestrial . . . . 24°6 on a. m. of 12th } 96°.4
Aurora observed on 3 nights, viz.:—on 3rd, 5th, and 28th.
Possible to see Aurora on nights 12; impossible on 19 nights.
Snowing on ... days; depth ... inches; duration of fall, ... hours.
Raining on 18 days; depth, 4 070 inches; duration of fall, 87.6 hours.
Mean of cloudiness=0.68; above average, 0.15. Most cloudy hour observed, 4 p.m; mean=0.73; least cloudy hour observed, mid't.; mean=0.62.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
2103.84	734.06	1133.15	1312.51

Resultant direction, N. 7° W.; Resultant Velocity, 1.86 miles per hour.
Mean velocity 5.64 miles per hour.
Maximum velocity 24.5 miles, from 2 to 3 p.m. on 10th.
Most windy day 27th—Mean velocity 12.64 miles per hour. } Difference 11.82.
Least windy day 8th—Mean velocity 0.82 miles per hour. }
Most windy hour, 1 to 2 p. m.—Mean velocity, 8.92 miles per hour. } Difference
Least windy hour, 4 to 5 a.m.—Mean velocity, 3.45 miles per hour. } 5.47 miles.

3rd, Faint Auroral light in N. and N.E at midnight.—5th, Solar Halo from 11.30 a.m. to 2 p.m., Auroral light and faint Streamers at 10 p.m. and midnight.—6th, Rainbow at 6.40 p.m , Lightning and distant Thunder at 10 p.m.—7th, Foggy and damp day.—8th, Foggy; Thunder in S.W. at 10 a.m.—9th, Lightning and distant Thunder at midnight; Foggy at 6 a.m.—11th, Hoar Frost and thin Ice at 6 a.m., Solar Halo and Parhalia at 6.20 a.m.—12th, Hoar Frost at 6 a.m.; pleasant day. 15th, Severe Thunderstorm, vivid Lightning and heavy Rain from 8.10 to 9 p.m.—17th, Distant Thunder 10 30 a.m. to 4 p.m.—20th, Solar Halo at 3 p.m.—23rd, Thunderstorm and incessant Sheet Lightning 10 p.m., and midnight.—24th, Solar Halo, 11.30 a.m. to 0.30 p.m.—25th, Ground Fog at midnight.—26th, Dense Fog.

May 1864 was comparatively mild, wet, cloudy, and calm.

COMPARATIVE TABLE FOR MAY.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above Average (45°5).	Maximum observed.	Minimum observed.	Range.	No. of days.	Inches.	No. of days.	Inches.	Resultant. Direction.	Resultant. Velocity.	Mean Force or Velocity
1840	53.8	+ 2.1	74.5	30.8	43.7	9	4.150	0	...	...	...	...
1841	50.5	— 1.2	76.2	26.6	49.6	11	2.350	1	...	...	...	0.35 lbs
1842	49.1	— 2.6	74.3	30.0	44.3	7	1.275	0	...	...	...	0.53 "
1843	49.1	— 2.6	79.6	28.9	50.7	5	1.570	0	0.0	...	...	0.52 "
1844	53.6	+ 1.9	77.7	29.0	48.7	14	5.670	0	0.0	...	...	0.30 "
1845	49.6	— 2.1	76.6	29.4	47.2	8	2.300	0	0.0	...	...	0.55 "
1846	55.5	+ 3.8	78.1	34.3	43.8	9	4.375	0	0.0	...	...	0.46 "
1847	54.4	+ 2.7	72.5	27.8	44.7	12	2.040	0	0.0	...	...	0.29 "
1848	54.1	+ 2.4	78.5	31.9	46.6	13	2.520	0	0.0	N 40 W	1.31	4.93 ms
1849	48.0	— 3.7	72.5	32.7	39.8	16	5.115	0	0.0	N 51 E	1.97	5.33 "
1850	47.6	— 4.1	76.3	31.1	45.2	7	0.545	1	Inp.	N 64 W	2.05	6.32 "
1851	51.3	— 0.4	73.2	28.7	44.5	12	2.950	1	0.5	N 32 W	1.59	6.34 "
1852	51.4	— 0.3	73.3	34.5	38.8	7	1.125	1	Inp.	S 82 W	0.99	4.00 "
1853	50.9	— 0.8	78.4	38.4	40.0	17	4.420	1	Inp.	N 2 W	0.83	5.16 "
1854	52.2	+ 0.5	69.0	27.6	41.4	11	4.630	0	0.0	E	0.40	5.38 "
1855	53.1	+ 1.4	74.8	33.9	40.9	6	2.565	2	0.9	N 1 W	2.76	5.93 "
1856	50.5	— 1.2	80.1	35.5	44.6	14	4.580	1	Inp.	N 4 E	3.99	9.81 "
1857	48.9	— 2.8	72.5	27.9	44.6	15	4.145	1	Inp.	N 23 W	1.14	8.13 "
1858	48.9	— 2.8	66.0	35.0	31.0	17	6.367	0	0.0	N 42 E	3.33	9.30 "
1859	55.2	+ 3.5	76.2	41.5	34.7	11	3.410	0	0.0	N 72 E	1.59	5.70 "
1860	55.5	+ 3.8	73.2	35.6	37.6	16	1.815	0	0.0	N 26 E	2.66	7.17 "
1861	47.5	— 4.2	72.0	29.1	42.9	12	3.380	1	0.5	N 47 W	3.60	9.17 "
1862	52.2	+ 0.5	77.8	38.1	39.7	8	1.427	0	0.0	N 52 W	2.80	7.87 "
1863	54.3	+ 2.6	77.1	38.1	39.0	14	3.363	1	0.1	N 56 E	0.41	5.89 "
1864	54.8	+ 3.1	74.2	35.3	38.9	18	4.070	0	0.0	N 7 W	1.86	5.64 "
Results to 1864.	51.68	...	74.98	32.47	42.52	11.6	3.206	0.4	0.09	N 6 W	1.46	6.59
Exc. for 1864.	+3.13	...	—0.78	+2.83	—3.62	+ 6.4	+ 0.864	— 0.4	— 0.09	...	...	—0.95

THE

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THE CANADIAN JOURNAL.

NEW SERIES.

No. LIII.—SEPTEMBER, 1864.

HISTORICAL FOOTPRINTS IN AMERICA.

BY DANIEL WILSON, LL.D.,

PROFESSOR OF HISTORY AND ENGLISH LITERATURE, UNIVERSITY COLLEGE, TORONTO.

With the facilities of intercourse which steam navigation has created between Europe and America, and the habitual resort of the settlers on the Western Continent, to the marts and centres of gaiety of the Old World, it is becoming more and more difficult for us to realise all that is implied in the date A.D., 1492, as that in which American history begins. Few facts in the history of our globe are more singular, than that one hemisphere should have remained utterly unknown to the other till the close of the fifteenth century; and the wondering admiration with which the discovery of the New World was then greeted by the Old, was not diminished by the disclosures that followed. New, indeed, the western hemisphere was, as is the planet Neptune, or the latest discovered asteroid; or as the Flint-Folk of the drift are new to us. But with the discoveries of Cortes and Pizaro, the men of Europe became gradually familiarised with the conviction that it was no new world they had found; but one with native relics of an ancient past: pyramids, temples, and hieroglyphics tempting to a comparison with those of Egypt; and sculptures, rites, and institutions of various kinds, all pregnant with suggestive resemblances to those of the oldest Asiatic nations.

In that fifteenth century it had not occurred to the boldest scientific adventurer to conceive of the possibility of men who were not of the race of Adam. Speculative philosophy and science were, indeed, venturing boldly on many novel courses; yet St. Augustine's demonstration, which had satisfied the men of the fourth century of the impossibility of antipodes, was reproduced with undiminished force to those of the fifteenth century: since to assert the existence of inhabited lands on the opposite side of the earth, and beyond impassable oceans, would be to contradict the Bible, by maintaining that the world was occupied in part by nations not descended from Adam. From this it naturally resulted that when, in spite of such demonstration, antipodes were discovered; and an inhabited continent had been explored beyond the Atlantic, presenting to the gaze of the Old World social and political institutions, arts, and sciences, the growth of unknown centuries of progress: the only question discussed was, from what centre of the Eastern hemisphere were those derived? Egypt, Phœnicia, Carthage, India, China, Spain, Denmark, Ireland, and Wales, each found its advocates: The lost Atlantis of Plato and Seneca; the Ophir of Solomon; the nameless Atlantic islands of Hanno, Pharaoh-Necho, and other early explorers; the sanctuary of the lost Ten Tribes; the Vinland of Leif Ericson; the Huitramannaland of the Norse rovers from Iceland; and the western retreat of Madoc, son of Owen Gwyneth, King of North Wales: have all been sought in turn, and have stimulated the ingenious fancy of sanguine explorers among the traces of America's unwritten history.

That nations, possessed of language, arts, and government, were in occupation of America, was proof enough that the human race—the unity of which was then unquestioned,—had diffused itself into the western hemisphere; and this idea presented itself at first in a less startling form, from the belief, in which Columbus died, that only a new route had been opened up to eastern Asia. The conviction of ancient intercourse between the eastern and western hemispheres, fostered by such means, has accordingly furnished fruitful themes for speculation, almost from the first landing of Europeans on the American continent. Exaggerated resemblances have been traced out in the arts and architecture of Mexico and Peru to those of Egypt and India. Their hieroglyphics and picture writing have been hastily pronounced to be the undoubted offspring of those of the Nile. Philological resemblances, astronomical chronology, and religious rites, have all been

forced into the service of favourite theories; and many ingenious and extravagant antiquarian romances, adapted to the popular taste by this means, have been welcomed as invaluable contributions to history: though in reality as insubstantial as the dreams of Merlin or the legends of Geoffrey of Monmouth. Nevertheless one class of monumental indices of intercourse between the eastern and western hemispheres, long prior to the fifteenth century, is of an indisputable kind. The Royal society of Northern Antiquaries of Copenhagen has placed the evidence of this before the world, in the most accessible form in the *Grönlands Historiske Mindesmærker*, and the *Antiquitates Americanæ, sive Scriptores Septentrionales rerum ante-Columbiarum in America.* The latter was issued from the Copenhagen press in 1837; and to this a supplement subsequently appeared, to the contents of which special reference will be made in discussing some of the supposed traces of the ante-Columbian colonisation of America. To those works, along with the correspondence and researches to which their preparation gave rise, is chiefly due the revived interest in the recovery of ancient traces of intercourse between the eastern and western hemisphere, which continued for some years to engross a large amount of interest among all classes in the United States.

From the literary memorials of the old Northmen thus restored to light, sufficient evidence has been disclosed to render highly credible, not only the discovery and colonisation of Greenland, by Eric the Red, a Norwegian colonist of Iceland,—apparently in the year 985,—but also the exploration of more southern lands, some of which must have formed part of the American continent. Of the authenticity of the manuscripts from whence those narratives are derived there is not the slightest room for question; and the accounts which some of them furnish are so simple, natural and devoid of anything extravagant or improbable, that the internal evidence of genuineness is worthy of great consideration. The exuberant fancy which revels in the mythology and songs of the Northmen, would have constructed a very different tale had it been employed in the invention of a southern continent for the dreams of Icelandic and Greenland rovers. Some of the latter Sagas do, indeed, present so much resemblance in their tales of discovery, to those of older date, as to look like mere varied repetitions of the original narrative with a change of actors, such as might result from different versions of one account, transmitted for a time by oral tradition before being committed to writing. But, notwithstanding

all reasonable doubts as to the accuracy of details, there is strong probability in favour of the authenticity of the American Vinland of the Northmen.

The Colonisation of Greenland, however, rests on no probabilities of oral or written tradition, but is an indisputable historical fact. In A.D., 999, Leif Ericson, the son of its discoverer, made a voyage to Norway, at the time when Olaf Trygvesson, the Saint Olave of Norse hagiology, was introducing Christianity into Scandinavia. Under the influence of the royal missionary, Leif Ericson abandoned paganism; and carrying back with him to Greenland teachers of the new faith, it found a ready acceptance among the Arctic Colonists. Greenland remained in connection with the mother country till the middle of the twelfth century, when it attempted to throw off its allegiance to Magnus, King of Norway, but was reduced to submission by an expedition despatched for that purpose by Eric, King of Denmark, whose niece was wedded to the Norwegian King.

There were two Norse colonies, those of east and west Greenland. The colonists of the western coast appear to have been exterminated by the Esquimaux; but the fate of those of the eastern settlement was long a mystery on which the modern Dane and Norwegian speculated as one of the obscure marvels of their race's history. It is obvious from the early details of the colony that the shores of Greenland must have been accessible in the twelfth and thirteenth centuries, to an extent wholly unknown in the experience of modern Arctic voyagers. In all probability the decay of the colonies is due to a considerable extent to climatic changes which had already, in the fourteenth century, begun to hem in the Greenland coasts with the icy barriers which for four centuries precluded all access to their inhospitable shores. But a great mortality among the voyagers trading between Norway and Greenland was occasioned in A.D., 1348, by a frightful plague known by the name of the *Black Death;* and it was long maintained that the whole Greenland colony had been exterminated by the same deadly scourge. Later accounts, however, still refer to the colonists; and the records of the reign of Queen Margaret—under whom the crowns of Denmark, Sweden, and Norway were united in 1397,—include references to the efforts then made to keep up the communication with Greenland. But political troubles at home speedily rendered the Queen indifferent to such remote dependencies. To all appearance, also, the Greenland coasts were being gradually hemmed in by

impassable barriers of ice, which cut off all intercourse with them subsequent to the close of the fourteenth century, and the very existence of the long lost region became a matter of doubt.

From time to time, however the subject was revived. Many a Norse legend and poem celebrated the charms of the Hesperian region which was fabled to lie embattled within the impassable Arctic barriers, clothed in the luxuriant verdure of a perpetual spring. In Iceland, where the old Norse colonists had maintained their ground, the faith in the ancient Greenland colonies remained unshaken; and received confirmation from various indications of the lost settlement, as well as from the definite traditions current among the Islanders, and narrated in their Sagas.

Among older memorials of Greenland and the mythic Vinland, it is recorded that towards the middle of the seventeenth century, an oar was drifted on the coast of Iceland bearing this inscription in runic characters: OFT VAR EK DASA DUR EK DRO THICK. *Oft was I weary when I drew thee.* To this the poet, James Montgomery, refers in the fourth canto of his *Greenland*, when following the later route of the Moravian Brethren in their generous exile:—

> "Here, while in peace the weary pilgrims rest,
> Turn we our voyage from the new-found west,
> Sail up the current of departed time,
> And seek along its banks that vanished clime,
> By ancient Scalds in Runic verse renowned,
> Now like old Babylon no longer found.
> "*Oft was I weary when I toiled at thee;*"
> This on an oar abandoned to the sea
> Some hand had graven. From what foundered boat
> It fell; how long on ocean's waves afloat;
> Who marked it with that melancholy line:
> No record tells. Greenland, such fate was thine:
> Whate'er thou wast, of thee remains no more
> Than a brief legend on a foundling oar;
> And he whose song would now revive thy fame,
> Grasps but the shadow of a mighty name."

Repeated unsuccessful attempts had been made by Norwegian, Danish, and English voyagers, at the time this poem was published, to effect a passage through the icy barriers around the east coast of Greenland; and it was not till 1822 that the enterprise of the distinguished Arctic voyager, Captain Scoresby, was rewarded with success.

Later explorations, however, shew that the sites of early colonisation had been more to the west, within Davis Strait; and there at length, in 1824, and subsequent years, well defined runic inscriptions and sepulchral records in the old Norse, or Icelandic language, have been brought to light; and are now for the most part deposited in the Christiansborg Palace at Copenhagen.

The result of such discoveries not unnaturally led to an eager desire to recover, if possible, similar traces of the early Norse Voyagers' visits to Vinland and other real or imaginary sites on the mainland of the American continent. In this there was nothing improbable; and should a runic inscription, analogous to those already brought to light at Kingiktorsoak, Igalikko, and other Greenland sites, reward the zealous researches of New England antiquaries, it would only confirm allusions to ante-Columbian voyages to the continent, already generally accepted as resting on good historical evidence. The search, however, has hitherto been attended with very ambiguous success, as shown in the well-known history of the Assonet or Dighton Rock inscription. Assuming that the voyages of Leif Ericson, Thorfinn Karlsefne, and other old Norse explorers, are authentic and indisputable, their visits to the American mainland were of no permanent character; and it may serve to illustrate the probabilities in favour of the recovery of any memorials of ante-Columbian voyagers, if we review such traces as are still discoverable, apart from direct written and historical evidence, of the actual presence of European settlers on the Continent of America, in the sixteenth, and even in the seventeenth century.

Among the remains of the ancient Norse colonists of Greenland, architectural memorials of a substantial character attest their perpetuation of European arts in their arctic settlements. The ruins of more than one ancient Christian edifice still mark the sites consecrated to religious services by the Norsemen who, while still pagans, sought a home in that strange region of the icy north. One of these primitive ecclesiastical ruins is a plain but tastefully constructed church of squared hewn stone, at Kakortok, in the district of Brattahlid. Though unroofed, the walls are nearly entire; and numerous objects of early European art, including fragments of church bells found in the same vicinity, confirm the evidence of the civilisation established and cultivated there by early colonists. Only a few miles distant from this ruined church the Igalikko runic inscription wa

found with its simple memorial of parental affection: VIGDIS M[AGNVS] D[OTTIR] HVILIR HER GLEDE GVTH SAL HENAR, i.e., *Vigdis, Magnus' daughter, rests here; may God gladden her soul.*

With such literate and architectural remains of the Greenland colonists of the tenth century still extant, it was not unnatural for New England antiquaries to turn with renewed vigour to the search for corresponding remains in the supposed Vinland of the same early voyagers, when the ancient manuscripts edited for the *Antiquitates Americanæ* had established the discovery of the continent of America by Norsemen of the tenth century. Among those, the members of the Rhode Island Society took a foremost part. They had already furnished materials for illustrating the venerable manuscripts edited in that imposing quarto, which seemed to its sanguine editors to place their dreams of a Norse Columbus of the Tenth Century beyond all dispute. The Assonet, or Dighton Rock, on the east bank of the Taunton river, which yielded to its antiquarian transcribers the long desiderated traces of runic epigraphy, has attracted the attention of New England scholars for nearly two centuries. Its history is alike curious and amusing, but need not be detailed here.* It is a detached rock, partly covered at high water, the exposed surface of which is covered with Indian devices rudely graven, aud greatly defaced by time. So early as 1680 Dr. Danforth executed a careful copy of it; and since then it has been again and again retraced, engraved, and made the theme of learned commentaries by New England, British, French, and Danish scholars; each striving in turn to enlist it in proof of the favoured theory of the hour; and to make out from its rude scratchings: Phœnician, Punic, Siberian, or Old Norse characters, graven by ante-Columbian voyagers in the infancy of the world. The triumphs of the antiquarian seers culminated in the year 1837, when the *Antiquitates Americanæ* issued from the Danish press, with elaborate engravings of this Dighton rock, from one of which—contributed by a Commission appointed by the Rhode Island Historical Society—its ingenious editor was able to furnish the interpretation of a "runic inscription" suddenly brought to light among the rude devices of the Wabenakies' picture-writing. The inscription was only too apt a re-echo of the Saga manuscripts; and indeed is now affirmed to have been the deliberate imposition of a foreigner resident at the time in New-

* Vide *Prehistoric Man*, Vol. II. p. 172.

port.* However it originated, certain it is that the so-called runic characters on the Dighton rock have vanished as completely as the faith in their marvellous historical revelations.

The literate evidence which the *Antiquitates Americanæ* furnishes in proof of the discovery of America by Northmen of the Tenth Century, rests on authority wholly independent of any real or fancied confirmation, derived from Greenland or New England inscriptions. The stimulus thereby furnished to antiquarian research was therefore no less strong than thoroughly legitimate. The members of the Rhode Island Historical Society accordingly renewed their search for traces of ante-Columbian art; and their attention was at once directed to a substantial piece of masonry which had occupied a prominent site at Newport, Rhode Island, beyond the memory of the oldest inhabitant. As a genuine American ruin of former generations the old Round Tower on Newport common forms an exceedingly striking feature; and the historical and literary associations ascribed to it, as well as the critical warfare which has raged around its site, and ransacked the mysteries of its very foundations, have added not a little to its genuine interest. When the antiquaries of Copenhagen were in search of relics of the long-lost Vinland, careful drawings of the old Tower were despatched to them, and welcomed as supplying all that they desired. Engravings reproduced from them illustrate the Supplement to the *Antiquitates Americanæ*, and the authentication of the old ruin as an architectural monument of the arts of Vinland and its Norse colonists of the eleventh and twelfth centuries is thus unhesitatingly set forth by Professor Rafn and his brother antiquaries of Copenhagen:—"There is no mistaking in this

* *The Controversy touching the Old Stone Mill in the Town of Newport, Rhode Island.* Newport. Charles E. Hammet, jr. 1851. p. 52. "The version of the inscription published in that work [the *Antiquitates Americanæ*], and distributed throughout Europe and America, was altered so as to make it appear to have been the work of the Scandinavians, by altering the characters, and adding in the body of the inscription, the characters ORINX which is said to be the name of one of their early navigators,"

The tracings on the rock read as OR, appear in an engraving so early as 1790; the remainder, which serve to complete the name—not of *Orinx* as stated above, but of *Thorfin*, with a concise record of his fifty-one followers,—appear for the first time in the copy made, and sent to Copenhagen in 1830. No one will believe, for a moment, that the members of the R. I. Historical Society had any hand in a fraudulent transcript, beyond their transmission of the drawing, executed either by some very credulous or designing copyist, of the rude and ill-defined Indian devices.

instance, the style in which the more ancient stone edifices of the North were constructed, the style which belongs to the Roman or ante-gothic architecture, and which, especially after the time of Charlemagne, diffused itself from Italy over the whole of the west and north of Europe, where it continued to predominate, until the close of the twelfth century. . . . From such characteristics as remain we can scarcely form any other inference than one, in which I am persuaded that all who are familiar with old Northern architecture will concur: that this building was erected at a period decidedly not later than the twelfth century."* Having thus settled the age of the venerable structure, and scornfully dismissed the idea of its erection for a windmill, as one the futility of which any architect could discern; that of its supposed primary destination as a watch tower is also rejected: and the final conclusion indicated is that it is an ecclesiastical structure which originally "belonged to some monastery or Christian place of worship in one of the chief parishes in Vinland. In Greenland there are still to be found ruins of several round buildings in the vicinity of the churches. These round buildings have been most likely Baptisteries;" and in proof of this, reference is made to an octagonal building forming part of the ruins of Mellifont Abbey, in the County of Louth, in Ireland.

To venture on questioning the genuineness of this Norse relic after these attestations of its credentials to such venerable antiquity, involved some degree of boldness. Its associations moreover, connect it unmistakeably with the olden time. It forms a central point in some of the romantic scenes of Cooper's "Red Rover;" and Longfellow, assuming its antiquity as amply attested for all a poet's purposes, has associated it with another discovery of so-called Norse relics, which was welcomed at the time as fresh confirmation of the Scandinavian colonisation of the ancient Vinland. An Indian skeleton was dug up at Fall River, Massachusetts, in 1831, buried in a sitting posture, wrapped in cedar bark, with some tubes, two arrow-heads, and other fragments of brass lying beside it. At any other time, the native origin of the whole would have been acknowledged beyond all dispute. But the discovery coincided with the researches of Professor Rafn and his colleagues at Copenhagen.† Thither accordingly specimens of the relics were sent. A portion of what was somewhat

Antiquitates Americanæ, Supp. p. 18.

† *Memoire sur la decouverte de l'Amerique au dixième siecle.* Copenhagen. 1848.

grandly designated the "pectoral," or "breastplate," on being submitted to the chemist, Berzelius, was found to bear a marvellous resemblance to modern brass; and an elaborate account of the "Discovery of Antiquities made at Fall River, Massachusetts," with the subsequent investigations, was published in the *Mémoires de la sociéte Royale des Antiquaires du Nord,* along with a letter from a learned Boston Antiquary on "the famous Dighton Rock, the marvel of this region," with its ancient characters, affording indubitable proof "that the Northmen have been on that spot."*

Here, at any rate, were ample materials for the poet. No better credentials could be desired for the hero of a genuine Norse Ballad, whatever the severer incredulity of the historical student might demand; and the Norse Viking, resuscitated from the skeleton in armour, speaks accordingly, narrating in his epical lyric, the ballad-legend of the Newport Round Tower. In response to the invocation of the modern Skald, the Viking recounts his passion, when,—like Othello, telling his adventurous tales,—the tender eyes of King Hildebrand's daughter kindled his heart with their soft splendour. But though they shone responsive, the royal father laughed his suit to scorn.

> "Why did they leave, that night,
> Her nest unguarded?"

Bearing from the Norwegian shore in flight with the blue-eyed maiden, the fierce Viking tells how he dashed mid-ships on his pursuers; and leaving Hildebrand and his crew to perish in the "blackwater," he sweeps fearless before the gale into the unknown West:—

> As with his wings aslant,
> Sails the fierce cormorant,
> Seeking some rocky haunt,
> With his prey laden:
> So towards the open main,
> Beating to sea again,
> Through the wild hurricane,
> Bore I the maiden.
>
> Three weeks we westward bore,
> And when the storm was o'er,
> Cloud-like we saw the shore,
> Stretching to leeward;

* *Mem. de la Soc. Royale des Antiquaires du Nord.* 1840–44. P. 117.

There for my lady's bower,
Built I the lofty tower,
Which, to this very hour,
Stands looking seaward.

But the modern Skald who rehearses the old Viking's tale, claims at the same time a poet's license. "That this building could not have been erected for a windmill," says Professor Rafn, "is what an architect can easily discern." "I will not enter into a discussion of the point," responds the poet. "It is sufficiently well established for the purpose of a ballad; though doubtless many an honest citizen of Newport, who has passed his days within sight of the Round Tower, will be ready to exclaim with Sancho, 'God bless me! did I not warn you to have a care of what you were doing, for that is nothing but a windmill; and nobody could mistake it but one who had the like in his head.'"

The controversy was still maintained among the New England Oldbucks and Wardours, when in 1847, a learned mediator dating from "Brown University, Providence," proceeded to publish, under the *nom de plume* of "Antiquarian," a series of abstracts from a joint Report of Professor Rafn of Copenhagen, and "Graetz of Gottenburg," and from an elaborate narrative prepared by "Professor Scrobein," a distinguished geologist, despatched to Rhode Island by the unanimous vote of the Royal College at Copenhagen. From the researches of this well accredited commissioner, the ruined tower is ascertained to have been "an appendage to a temple, and used for religious offices, as a baptistery or baptismal font. It appears to have been erected by the Northmen, in the eleventh century, during a sojourn of Bishop Eric in Vinland, as the island was called, from the excellency of its wine and abundance of its grapes." Excavations within the ruin brought to light "the foundations of the *receptimum*, or place where the candidates stood while receiving the baptismal shower . . . In close proximity to this was a second foundation, that of the *palestrium*;" and the discovery was completed, and placed beyond all dispute by the finding of various ancient coins, including "some of Henry II. 1160, which would lead us to believe that some kind of commercial intercourse existed in those days."

To the manifest delight of the rogue—an undergraduate we may surmise,—who palmed off this grave hoax on the Rhode Islanders, it was taken up seriously. "Graetz of Gottenburg" passed muster under

the wing of the veritable Rafn of Copenhagen. "Bishop Oelrisher" who bequeathed the 1400 reichsthalers needed for prosecuting the interesting inquiry escaped challenge. But an elderly disputant, "one of the oldest inhabitants," indignantly affirmed the falsity of Professor Scrobein's report; that he had been grossly deceived; that he had no hand in the report attributed to him; and only neglected to inquire if anybody at Copenhagen or elsewhere had ever before heard of this mythic Professor, whose report, as the venerable controversialist maintains, "was a gross and palpable imposition on the [Copenhagen] committee, the Royal Society and the world." The "Antiquarian" of Brown University gravely responded with still more startling extracts from the Professor's report; which document, says he, "I would willingly submit, but its extreme length forbids!"* And so the old mill grew ever more famous. More than one poet added his contribution to its renown; and in the "Poem of Aquidneck," the muse thus questions and solves its controverted points of history:—

How long hath Time held on his mighty march
Since first arose thy time-defying arch?
Did thus th' astonished Indian gaze on thee,
A mystery staring at a mystery?
A son of Canaan shall we rather say,
Viewing the work of brethren pass'd away?
Was it Phœnician, Norman, Saxon toil
That sunk thy rock-based pillars in the soil?
How looked the bay, the forest, and the hill,
When first the sun beheld thy walls, old mill?
Alas! the Antiquarian's dream is o'er,
Thou art an old stone windmill,—nothing more!

The Norse builders and ante-Columbian date of the Newport Tower, which found in earlier days as zealous champions as the Phœnician origin long ascribed to the Round Towers of Ireland,—after being thus subjected to the sly assaults of the satirist, as well as the severe questioning of grave critical censors,—have been so universally abandoned, that some may perhaps deem it scant courtesy to recall the forsworn creed. In reality, however, this chapter in the history of American archæological research is replete with interest and value. But for the investigations into the significance of the

* *Controversy touching the Old Stone Mill in the Town of Newport, Rhode Island.* Newport, 1851, p. 16.

Dighton Rock inscription, extending over nearly two centuries; and the more recent researches into the origin and history of the Newport Tower: we might have good reason to assume that all inquiry after historic footprints had been delayed until their last traces had been obliterated by successive generations of colonists in the long-settled New England States. Happily, the history of the Dighton Rock refutes this assumption, and furnishes good reason for believing that no important ante-Columbian monument has disappeared within the period of Anglo-American occupation. The long unheeded Round Tower adds its confirmation to the same belief. Probably no member of the Rhode Island Historical Society now doubts that in the picturesque ruin which has acquired an additional interest by the learned strife to which it has given rise, we have the identical structure referred to in the will of Benedict Arnold, first governor under the Charter granted by Charles II. to the Colony of Rhode Island, and Providence plantations, in 1663. He had removed from Providence to Newport ten years previously; and in his will, dated there, the 20th of December, 1677, he thus directs: "My body I desire and appoint to be buried at ye North East corner of a parcel of ground containing three rod square being of and lying in my land in or near ye line or path from my dwelling-house leading to my stone built wind-mill in ye town of Newport." In another clause he bequeathes the same "stone built wind mill" to his wife Damaris Arnold, and after her decease to his youngest daughter, Freelove Arnold, having provided for his elder daughter, Godsgift, in other clauses. The names are characteristic of the old Puritan, whose father was one of those who came from Salem to Providence, and shared the latter with Roger Williams in 1636. An entry in the Journal of Peter Easton, one of the first settlers, records, under the date of Aug. 28th, 1675, a great storm, which "blew down our wind mill and did much harm."* The brief interval between this date and that of Governor Arnold's will, leaves little room for doubt as to that of the stone-built one which he there devises to his heirs. The date and its associations, though unacceptable to those who would fain decypher runic inscriptions of the tenth or eleventh century on the Dighton Rock, identify the first Norse discoverers, and trace out their settlements in the Vinland of the Sagas: is nevertheless one sufficiently near that initial date of A.D.

* *The controversy touching the Old Stone Mill in the Town of Newport, Rhode Island.* Newport, 1851, p. 64.

1620, when the Pilgrim Fathers landed on Plymouth Rock, to give the old ruin on Newport common as great a value in the eye of every true hearted American, as the CATT STANE can claim from the British antiquary who believes that its rude letters record the burial-place of Vetta son of Victus, son of Woden, the lineal ancestor of Hengist, the Teutonic colonist of England.

A picturesque old relic, known *par excellence* as The Old House of Boston, stood till 1860 at the corner of North and Market Streets of the New England Capital, with its quaint gables, and overhanging oaken-timbered walls, such as abound in the old capitals of Europe, and look as if they had been built before the laws of gravitation had a being. The date latterly assigned to it was 1680; but the march of improvement knows no antiquarian sympathies; and a range of modern warehouses has usurped the site of the venerable civic relic. Here and there among the burial grounds of New England and other older States, weathered and half-defaced stones commemorate the worth of early colonists; and doubtless some lie buried, where they may be found in other ages, when the Roman characters and English language of the sixteenth and seventeenth centuries will seem as strange to the eyes of a new generation as the runes of the Greenland Norsemen do to our own. But a recent discovery towards the northern limits of the New England States suffices to encourage the hope that still earlier traces of the first European colonists may yet gratify intelligent curiosity with glimpses of the beginnings of America's history. This new found historical footprint of the seventeenth century, only brought to light in the autumn of 1863, is a plate of copper measuring ten inches by eight, found at Castine, in the State of Maine,—the old Indian Pentagoet,—near the mouth of the Penobscot river, famous with the Kennebunk, or Kennebec, as it is now called, as marches of the French and English debateable land, subsequent to the treaty of Aix-la-Chapelle. It was discovered in the course of excavations made in constructing a battery at the mouth of Castine harbour.* The corroded sheet of copper attracted no attention when first restored to light; nor was it till its discoverer had cut a piece off it to repair a boat, that his attention was drawn to the characters engraved on its surface. Fortunately the detached piece was easily recovered; and on being restored to its place, the inscription was decyphered as follows:

* *Proceedings of the American Antiquarian Society*, April, 1864. p. 60.

1648 . 8 .. IVN . F.
LEO PARIS . IN .
CAPVC . MISS.
POSVI HOC FV-
NDTM IN HNR-
EM NRÆ DMÆ
SANCTÆ SPEI

The inscription, it will be seen, commemorates the erection in what was then a part of *La Nouvelle France*, of, as may be presumed, a Mission Chapel of the Capuchins, dedicated to our Lady of Holy Hope. Charlevoix, in his *Histoire Géneral de la Nouvelle France*, refers to a visit of the Jesuit Father, Dreuillettes, to a Hospice of the Capuchin Fathers on the Kennebec river, in 1646; and states that at that date,—only two years before the event commemorated in the inscription,—they had another mission house at Pentagoet. The Capuchin Fathers were a fraternity belonging to the Franciscan Order of Mendicant Friars, whose mission here, and in the Kennebec region, appears to have been, not to the Indians, but to the French colonists of Acadia and the neighbouring mainland. The inscribed plate records the laying of the foundation stone in which it was deposited, by brother Leo of Paris, at the date named; and may be read in extenso thus :—1648, 8 *junii, frater Leo Parisiensis, in Capucinorum missione posui hoc fundamentum in honorem Nostræ Dominæ Sanctæ Spei.*

The date, though so modern, according to the estimate of European antiquaries, carries the mind back to a very primitive period in the history of Maine; and the interest of the inscription is enhanced by the associations connected with the site of the building it commemorates. "Few spots on the coast of New England can boast so much natural beauty, and none has had the vicissitudes of its history so interwoven with the history of different nations, as the peninsula of Pentagoet, Penobscot, Castine." The date also has its own peculiar significance in the past history of the New England States. This might be illustrated by various contemporary events. Perhaps the most memorable, as it is the most characteristic, is that in that very year—when Europe was arranging the peace of Westphalia,—witchcraft came to a head in the New World, and the first of the New England witches was hanged in Massachusetts Bay.

Corresponding memorials of an earlier date doubtless lie undisturbed beneath the older foundations of churches and hospices of Lower Canada. The little church of Tadoussac, at the mouth of the Saguenay, still occupies the site consecrated to the service of God, on what was one of the earliest settlements in the New World. A trading post was established there by French fur-traders, under the special favor of Henry IV.; and contracts were entered into by two merchant traders of Rouen and St. Malo for its colonisation as early as 1599. Within very recent years the remains were still visible of a stone mansion built by Captain Chauvin who died there in 1603, after having made two voyages with settlers to Tadoussac. A slighter, yet more enduring memorial of the old colonists attracted my attention when visiting the spot, in the scattered tufts of Sweet William, Mignionette, and other garden flowers, repeating the tale of Goldsmith's Deserted Village:

> "Where once the garden smiled,
> And still where many a garden flower grows wild."

Jamestown, Virginia, which claims to be the earliest settlement on the American continent, was founded by the English Captain, Newport, in 1607, and on the 3rd of July, in the following year, Champlain laid the foundation of Quebec. The site of the first fort is now occupied by the venerable church of *Nôtre Dame des Victoires*, one of the oldest edifices in the City of Quebec, which received its present name on the defeat of the English forces under Sir William Phipps, in 1690. But the most curious inscription now visible on the old-fashioned buildings of the picturesque capital of Lower Canada, is one accompanying a quaint piece of sculpture known as the *Chien d' Or*, a work of the following century. But modern though it is, tradition has already confused its associations and forgotten its significance. Over one of the windows of an old house near the Prescott Gate, now used as the Post Office, is an ornamental pediment, the centre of which is occupied by a slab of dark limestone, on which a dog is sculptured in high relief and gilded, represented gnawing at a bone; and beneath it this inscription:—

> "Je suis un Chien qui ronge mon os,
> En le rongeant, je prends mon repos,
> Un jour viendra qui n'est pas venu,
> Ou je mordrai, qui m'avra mordu."

The house is said to have been the mansion of a wealthy Bordeaux

merchant, who put up this piece of sculpture, with the accompanying quatrain, as a lampoon on M. Bigot, French Intendant and President of the Council; and paid for his caustic wit with his life. But the date of the assassination of M. Philibert, the supposed lampoonist, is proved to have been long subsequent to that of 1732, inscribed on the stone; and the origin and special significance of the inscription remain an enigma.

In the able and well digested resumé of American Archæology prepared by the learned librarian of the American Antiquarian Society, he remarks: "We should be glad to see gathered into one chapter, under an appropriate head, all the evidences of Art beyond the ability of the natives, that must be assigned to an ante-Columbian period, and all other indications of a foreign people, before that era, in the United States. They cannot be numerous; and the point is of sufficient importance to be distinctly presented with all the force it possesses. They have hitherto proved unsubstantial whenever we have attempted to grasp them."* The Dighton Rock, the inscribed rock on Cunningham's Island, Lake Erie; the much controverted "Grave Creek Stone;" and a contemptibly gross forgery with the date 1587, "discovered, according to most respectable authority, on a plate of mica upon the breast of a skeleton, buried after the ancient manner, in a mound near that at Grave Creek, from whence the more celebrated inscribed stone was derived:" are all noticed, and some of them dismissed too gently by their courteous reviewer.

The invention of spurious inscriptions: from the notorious gold plates of the Mormon Gospel, to the "Ohio Holy Stone," and the new version of the Ten Commandments, partly in Hebrew and partly in unknown characters, engraved on a stone tablet, discovered under an ancient mound at Newark, Ohio, in 1860; have for the most part been the work of such illiterate and shallow knaves, that they scarcely merit serious notice, were it not for the amount of discussion they excited, before the all engrossing civil war preoccupied the public mind with its stern realities. The former relic, clumsily made out of common hone-stone, has been repeatedly engraved. A State Geologist of high repute pronounced its material to be "*novaculite*, a stone entirely unknown among the rocks or minerals of the Ohio region;" and a distinguished free-mason, "well informed upon the history of his order, and upon antiquities in general," certified that "the stone was one

* *Archæology of the United States*: by W. F. Haven. p. 134.

used by masons of a certain grade in the East, soon after the building of the first temple by Solomon, and before the erection of the second," —with much else equally wonderful; so that the HOLY KEY-STONE, as it was now designated, became an object of immense interest to American free-masons. The discussions on the authenticity and significance of the mound-version of the Decalogue fell with equal propriety into the hands of divines, though not without other learned aid. The Rev. J. W. McCarty, Rector of Tr nity Church, Newark, was the first to interpret the mysterious characters. The Rev. Theodore Dwight confirmed his interpretation, and proved the antiquity of the inscription by references to Gesenius, comparisons with rare coins of the Maccabees, and remarkable coincidences with the Samaritan version. J. J. Benjamin, "perhaps the best Hebrew scholar now in this country, whose home is in the Turkish Province of Moldavia, and who is now in this country for the purpose of prosecuting researches among the Indians for evidences of the Lost Tribes," with the aid of an interpreter, gave new readings; until not a few rejoiced in the belief that the veritable sepulchre of Moses had at length been discovered,—not in a valley in the land of Moab, over against Beth Peor; but in the Newark valley, in the State of Ohio.*

The favourite idea of finding the Lost Ten Tribes among the Red Indians of the New World, which pervades Lord Kingsborough's elaborate work, and played a prominent part in the speculations of the earlier American ethnologists and antiquaries, lies at the root of this class of marvels. It retained its hold on the popular mind as long as such subjects possessed any attractions; and notices of the discovery of shekels and other Hebrew relics could be easily multiplied by a little research in the files of Western American newspapers. The Rev. George Duffield, of Detroit, furnishes one account of a Hebrew Shekel, found in Indiana among the bones supposed to have been thrown out of an ancient mound; and conjectured to be of the time of the Maccabees.† The discovery of a large hoard at Jerusalem, in recent years, has rendered the silver shekel a coin by no means rare; though its appearance might well excite wonder, among the genuine contents

* *Cincinnati Commercial*, July 12th, 1860; Nov 5th, 7th, &c. *Newark North American*, July 5th. 1860, &c. *Harper's Weekly Journal*, Sept. 5th 1860. *New York Independent*, March 14th, 1861. *A representation of the two stones, with the characters inscribed on them, that were found by D. Wyrick, during the summer of* 1860, *near Newark, Ohio;* &c., &c.

† Schoolcraft's *History of the Indians*. Vol. iv. p. 149.

of a Western Indian mound. "We have at hand," says Mr. Haven, "Jewish phylacteries that were taken from beneath the soil, in a country village, where it was declared Jews were never known to have been; but a follower of Moses was ultimately traced to the very spot where these were found."* The *Eagle* newspaper of Jackson, Missouri, describes "a veritable Egyptian coin," found there in December, 1858, about thirty feet below the surface, in digging a well; and comments on the evidence thus furnished from time to time, "that the country was known centuries before the time of Columbus, not only to the Northmen and other Europeans, but to the Egyptians, the Phœnicians, and even to the Chinese." Similar notices of the recovery of ancient coins have been repeatedly published; and, considering the zeal devoted to numismatic collections in America, it is far from improbable that an occasional stray waif from these cabinets may have furnished genuine materials for such a discovery. But it is to be feared that the majority of them are no better authenticated than the reputed find of the apochryphal Professor Scrobein, among the foundations of the Newport Round Tower.

Of another class of Antiquities is "the Alabama Stone," an innocent piece of blundering, not without its significance. It was discovered near the Black Warrior River, about forty years ago, when no rumours of the old Northmen's visits to Vinland stimulated the dishonest zeal of relic hunters, or tempted the credulity of over-zealous antiquaries; and so its mysterious Roman capitals and remote ante-Columbian date were only wondered at as an inexplicable riddle. As originally transcribed this record of the thirteenth century ran thus:

HISRNEHNDREV.
1232

Had this Alabama stone turned up opportunely in 1830, when the Antiquaries of New England were in possession of a roving commission on behoof of Finn Magnussen and other Danish heirs and assignees of old Ari Marson, who knows what might have been made of so tempting a morceau? From the *Annales Flateyenses*, we learn of "Eric Grœnlandinga biskup" who, in A.D., 1121, went to seek out Vinland; and in the following century the *Annales Holenses*, recovered by Torfæus from the episcopal seat of Holum in Iceland, supply this tempting glimpse: "*faunst nyja land*," i.e., new land is found. With

* *Archæology of the United States*, p. 135.

such a hint what might not learned ingenuity have done to unriddle the mysteries of the New World in the year of grace, 1232? Unhappily its fate has been to fall into the hands of Mr. Samuel F. Haven for literary editing, which he does in this unromantic fashion :

"We have before us the 'Alabama Stone' found, some thirty years ago, near the Black Warrior river. To our eyes it reads HISPAN. ET IND.REX. as plainly as the same inscription on a Spanish quarter of a dollar somewhat worn. The figures may be as above represented, but of course they cannot be intended for a date," unless indeed it be 1632. The "Rutland stone," duly honoured in the *Antiquitates Americanæ*, next comes under review, with its supposed characters graven and then filled in with a black composition. But this is a counterpart to the famous "Runamo Inscription" cut on the surface of a flat rock at Hoby, between Carlshamn and Runamo in Bleking, a Province of Sweden. Saxo Grammaticus tells us in the preface to his *Historia Danica* that King Waldemar the Great, in the twelfth century, sent emissaries skilled in Runic lore to read and copy the inscription. Olaus Wormius tried it again nearly five hundred years after. But what both had failed to decypher, Professor Magnusen of Copenhagen mastered in 1834, and made it out to be an inscription in old-northern runes, and regular alliterative verse, referring to the heroes in the battle of Braavalle, fought, A.D., 680. To no fitter seer could the "Rutland Stone," with its regular series of literal characters, be despatched. But, alas for the credit of the Antiquarian craft, the Runamo inscription had by this time been discerned to be nothing more than the natural markings on a block of graphic granite: and to the same class of relics the Rutland Stone must be referred. Old enough it is for the most ambitious stickler for the antiquity of the New World; ancient indeed as the oldest of those records interpreted by the author of "the Testimony of the Rocks;" and inscribed by the same hand that formed its rocky matrix.

But from such learned and unlearned blunderings,—not without their value from the curious illustrations they afford of the change from the exclusive pedantry and dilettantism of the eighteenth century of Europe, to the widely diffused, but superficial knowledge of the American nineteenth century;—it is pleasant to turn to an inscription of early date which invites consideration as a genuine, though rudely executed record of the sixteenth century. The "Manlius Stone," now referred to, was discovered about the year 1820, in the

Township of Manlius, Onondaga County, New York, by a farmer, when gathering the stones out of a field brought for the first time into cultivation. It is an irregular spherical boulder, about fourteen inches in diameter, now deposited in the Museum of the Albany Institute. On one side, which is smooth and nearly flat, the following inscription is rudely, but regularly cut, with the device, at the dividing line, of a serpent twining round a tree:

Leo. De	L: :11
VI, 1520	×

The letters on the right side are somewhat defaced; but the stone looks like a rude memorial hastily executed by some explorer, on the most convenient tablet at hand, either as a memento and evidence of his having reached the spot,—in itself a fact of no slight interest, when the date and locality are considered;—or as the record made by some friendly hand to mark the last resting place of a companion who had persevered thus far among the first explorers of the New World's mysteries. But like most American inscriptions, that of the Manlius Stone has been tortured into meanings not very easily discernible by any ordinary process of interpreting such simple records. "By the figure of a serpent climbing a tree," says one ingenious decypherer* "a well-known passage in the Pentateuch is clearly referred to. By the date the sixth year of the reign of the Pontiff, Leo X. has been thought to be denoted. This appears to be probable, less clearly from the inscriptive phrase: *Leo de Lon VI.* than from the plain date, 1520, being six years after the Pontiff took the chair:" which, however, it is not, as Giovanni de Medici succeeded Julius II. in March, 1513. Mr. Buckingham Smith recently submitted to the American Antiquarian Society a paper devoted to the elucidation of inscribed stones found on ancient Indian sites,† among which he includes both the Grave Creek Stone and the Dighton Rock. Applying the same rule to those as to the Manlius Stone, he discovers in their characters, initials or ciphers used in the Catholic church, and renders them as abridged invocations to Christ and the Virgin Mary. Of the Manlius Stone he says, with more hesitation, "as, in the year of Christ, 1520, Giovanni de Medici (Leo X.) sat upon the Papal throne, the words might possibly have been LEO DEcimus PONtifex MAXimus." Again the same inscription is assumed by another interpreter to be

* Schoolcraft's *Notes on the Iroquois*, p. 326.

† *Proceedings of the American Antiquarian Society*, April, 1863, p. 33.

a memorial of Juan Ponce de Leon, the discoverer of Florida, and to "tally exactly with the sixth year after his landing;" which, however, it does not, as that took place on *Pasqua Florid*, or Palm Sunday, A.D., 1512. The attempt, indeed, to identify the name thus rudely graven on a stray boulder, either with that of the sovereign pontiff, Leo X. or with Don Juan Ponce de Leon, is only less extravagant than the persistent decyphering of that of the Icelandic Thorfinn on the Dighton rock.

Apart, however, from any such special identification of the object of the memorial on the Manlius Stone, it is a relic of considerable interest. No reasonable grounds exist for questioning its genuineness; and we are thus supplied with an inscription of a date within eighteen years of the first landing of Columbus on the mainland; and only six years susequent to Sir Walter Raleigh's first expedition to the country which, on the return of his exploring party, received the name of Virginia. A discovery of this nature, associated with the earliest known period of European exploration of the American continent, in a locality so far to the northward, and so remote from the sea coast, when taken into consideration along with the authentic traces of older Scandinavian settlement still discoverable in Greenland, is calculated to confirm the doubts of any Scandinavian colonisation of Vinland in ante-Columbian centuries. That the old Northmen visited some portions of the American coasts appears to be confirmed by credible testimony; but that their presence was transient, and that they left no enduring evidence of their visits, seem no less certain. To the Spanish pioneers of American discovery and civilisation in the centuries subsequent to the era of Columbus, we must therefore look for the earliest memorials of European adventure in the New World.

The lettered traces of the early Spanish explorers of America are definite, and generally easily deciphered inscriptions, like those of the older colonists of Greenland; and possess an inferior historical value, chiefly because of the ample materials provided by Spanish chroniclers for the history of the discovery and conquest of Spanish America. In 1850 a series of reports made to the Topographical Bureau of the United States, was issued from the War Department at Washington; and among these is the journal of a military reconnoissance from Santa Fe, New Mexico, to the Navajo Country, in 1849, by Lieutenant James K. Simpson of the Corps of Topographical Engineers. His narrative is accompanied with illustrations of a remarkable series of

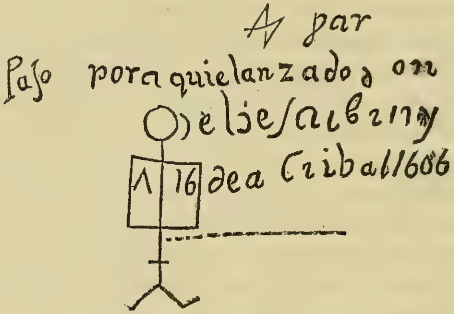
inscriptions engraved on the smooth face of a rock of gigantic proportions called the Moro. The route of Lieutenant Simpson lay up the valley of the Rio de Zuñi, and there, as he informs us, he met Mr. Lewis who had been a trader among the Navajos, and was waiting to offer his services as guide to a rock, upon the face of which were, according to his repeated assertions, "half an acre of inscriptions." After passing over a route of about eight miles, extending through a country diversified by cliffs of basalt, and red and white sand-stone, in every variety of bold and fantastic form, they came at length in sight of a quadrangular mass of white sand-stone rock, from two hundred to two hundred and fifty feet in height. This was the Moro, or Inscription Rock, on ascending a low mound at the base of which, the journalist states, "sure enough here were inscriptions, and some of them very beautiful; and although, with those we afterwards examined on the south face of the rock, there could not be said to be half an acre of them, yet the hyperbole was not near as extravagant as I was prepared to find it." On the summit of the cliff the ruins of a pueblo of bold native masonry formed a rectangle two hundred and six by three hundred and seven feet; around which lay an immense accumulation of broken pottery, of novel and curious patterns.

The inscriptions are of two classes: the native hieroglyphics, which furnish no means of judging of the dates of the oldest of such symbolic writings; and the Spanish inscriptions and devices. The longer examples of the latter class appear to be mostly imperfect, through the action of time and the defacement of later visitors. But they have not been subjected to such careful study, by competent transcribers, as to ensure their complete reproduction, or conjectural restoration; and it is probable that future explorers may be rewarded by the discovery of many additional records of interest and historical value. One apparently reads thus:—

> ✝ *Pasamos por aqui*
> *el sarjente mayor*
> *y el capitan Jũ de Arechu-*
> *seta y el viadante Diego Martin*
> *Barba y el Alferes Guillen de Ynes*
> *Josana A.* 1636.

Another, and apparently the oldest with a date affixed, A.D. 1606, is given here in facsimile. But others are in an earlier character,

and, it can scarcely be doubted, include inscriptions of the previous century.



MORO INSCRIPTION: A.D. 1606.

The name of the old Spanish explorer who found time to engrave this unfaithful memorial of his visit is no longer decipherable, in consequence perhaps of the haste of its recorder, who thus tells us that on the 16th April, (?) 1606, he passed the Moro Rock with despatch. Older records than this, dated as well as undated, may yet reward the research of future explorers; for Lieutenant Simpson could only devote a portion of one day to their transcription; and the Abbé Domenech, who refers to them in his "*Seven Years' Residence in the Great Deserts of North America,*" as inscriptions that "have never been mentioned in any scientific or geographical work published in Europe," merely reproduces a partial and inaccurate version of Lieutenant Simpson's report.

Some few of the Moro Inscriptions are in Latin; but the greater number are in Spanish, and are occasionally accompanied with pictorial devices, or rebuses, somewhat after the Indian fashion of picture writing. One, for example, reads *Pito Vaca ye Jarde,* with the accompanying symbol of the *Vaca,* or cow. Another group, consisting of certain initials interwoven into a monogram, accompanied by an open hand with a double thumb, all enclosed in cartouch-fashion, is supposed by the transcriber to be, even more literally than the previous bit of pictorial symbolism, a pictured pun. "The characters," he remarks, "in the double rectangle seem to be literally a sign-*manual,* and may possibly be symbolical of Francisco Manuel, though the double thumb would seem to indicate something more." The

device thus ingeniously interpreted includes an interwoven monogram of European characters, and the open hand, a symbol of frequent occurrence among the Indian hieroglyphics of this and other regions; though not as here, with the novel adjunct of the double thumb. It is perhaps, in the simple form in which it is introduced in groups of Indian symbolism, the same "Red Hand" which Stephens observed with such interest wherever he wandered among the ruins of Central America. Here, however, it is the work of the designer; and the monograph, which its transcriber reads as Francisco, appears more like the sacred monogram I. H. S. Perhaps it is thus placed, with an obvious significance, along side a native symbol of the Deity, or of one of his impersonated attributes. On the same face of the rock where this device occurs, is the following elaborate, though partially mutilated piece of local history, somewhat in the florid style of Oriental epigraphy :—

G. y Cap^{an} Gen^{l} de las Pro^{as} del Nuevo Mex^{co} por el Rey ñro S^{r} pasó por aqui de vuelta de los pueblos de Zuñi á los 29 de Julio del año de 1620, los puso en paz á su pedim^{to} pidien dole su favor como vasallos de su Maj^{ad} y de nuevo dieron la obedienci, to do lo qual hizo con el agasajo solo, y prudencia como tan christianisimo . . . tan particular y gallardo soldado indomitable y loado amemos . . .

Joseph Errămos ✝ *Diego Nuñez Bellido* ✝
G^{ral} y el Sapata Bartolom^{e} Narrso.

Lieutenant Simpson learned from the Provincial Secretary, Don Aciano Vigil, that though the conquest of the Province was originally effected by Juan de Oñate, in the year 1595, all records preceding the year 1680 have perished, as the Indians burnt the archives in an insurrection against the Conquerors at that date. On this account therefore, the Moro Inscriptions have even some historical value ; and among these the one quoted above may be classed. The proper names occur so far apart from the main inscription that their connection in the form assumed by the original transcriber, is doubtful. Translated, it reads: The Governor and Captain General of the Provinces of New Mexico, for our Lord the King, passed this place, on his return from the Pueblo of Zuñi, on the 29th of July, of the year 1620, and put them in peace, at their petition, asking the favour to become subjects of his Majesty, and anew they gave obedience ; all which they did with free consent, knowing it prudent,

as well as very christian . . . to so distinguished and gallant a soldier, indomitable and famed, we love . . . Joseph Erramos + Diego Nuñez Bellido + General and Counsellor, Bartolomeo Narrso.

Great credit is due to the intelligent zeal of the officers by whom the series of Moro inscriptions were copied, under such disadvantageous circumstances, with so much care; but a more prolonged visit to the same interesting locality will probably hereafter amply repay the labours of some enterprising explorer, and add perhaps to our present materials, by the discovery of ancient native, as well as early European inscriptions of great value. The Dighton Rock sinks into insignificance amid the numerous devices and hieroglyphics graven by native artists on the Moro Cliffs, from among the lines and markings of which an ingenious fancy need find no difficulty in selecting equivalents for more than all the ancient languages affirmed to be represented in the polyglot alphabet of the Grave Creek Stone.

One other authentic memorial of the early presence of the Spaniards in the New World is derived from a different locality. In the year 1847 a stone tablet, engraven here with its curious heraldic blazonry, was found on one of the North Chincha islands off the coast of Peru, buried in the accumulated guano of centuries to a depth of eighteen feet. The shield is quartered heraldically, and pierced at the intersection with a square socket, possibly for the insertion of the beam to which a beacon-light or lantern was attached. In the first quarter is a house, or church, with a belfry-tower and bell; and over this the abbreviated word DOM. The second compartment is charged with a pelican, of which there are myriads about the guano islands; and the inscription, running on into the fourth quarter, reads: PEDRO GV^{R} CHN ISA. The device on the third quarter, is an arm holding a blazing torch, with an inscription of which the only word now decypherable is QVEMA, *burns*. The fourth quarter bears three Islands, no doubt intended for those of the Chincha group. So far as the whole is decypherable it may read simply: *The house of Pedro, Governor of the Chincha Islands;* which the device in the first quarter of the shield probably represents correctly as no palatial edifice. But the use suggested for the socket in the centre of the shield accords with the destination which its blazonry suggests for the tablet, as the decoration of a beacon-tower attached to the residence of the insular Spanish Viceroy.

The sculptured tablet exhumed from the guano bed of the Chincha Islands, and now deposited in the British Museum, is thus a memorial of the early appropriation by the Spanish conquerors of Peru. of what we know were among the most prized possessions of the Incas long before the advent of Pizaro and his unscrupulous conquistadors. The chronological significance of the depth at which it was found receives some illustration from other discoveries subsequently made.

CHINCHA TABLET.

In May, 1860, Messrs. Trevor and Colgate, bullion dealers, New York, exhibited to the American Ethnological Society four gold relics, which formed part of a discovery made on the same Chincha Islands, by some Coolies engaged in digging graves. They included the rudely executed figure of a man, wrought with the hammer and punches, from a piece of gold weighing about twelve gold dollars; and three cups of the same metal, wrought in like manner with the hammer, and weighing about five gold dollars each. But the most interesting fact in relation to those curious native relics is that they were recovered at a depth of upwards of thirty feet below the original surface of the guano; and they carry us back centuries before the period when the sculptured memorial of the Spanish intruders, described above, was abandoned to the same slowly accumulating sepulture.

Such then are a few highly characteristic illustrations of the footprints of early American explorers and settlers, which, without attempting any exhaustive treatment of the subject, may suffice for the purpose now in view. The sculptured tablet, the engraved plate, the medal, and the coin, are nearly indestructible. Wherever they have been left they are sure, sooner or later, to turn up ; and already, as we see, chance discoveries on widely scattered localities, carry us back wonderfully near the first well established dates of permanent settlement on the chief centres of early occupation. The Northmen colonised Greenland nearly eleven hundred years ago, and their memorials remain to this day, as indubitable as those of the Romans in transalpine Europe. The Spaniards took possession of the American mainland six centuries later, followed by the Portugese, the French, and the English ; and the traces of all of them carry us back wonderfully near the earliest dates of their presence there. We know, moreover, from the amusing history of the Dighton Rock inscription, that the subject has attracted a lively and even eager attention for nearly two centuries ; and since the revival of the traditions of the long lost Vinland, ante-Columbian inscriptions and memorials have been sought for even with an undue excess of zeal. The antiquaries of New England have done good service to the historian by their thorough exploration of all real or imaginary traces of ante-Columbian colonisation ; and have no special reason to blush for the ardour with which they have been stimulated in the pursuit of so tempting a prize. If, however, some of them are inclined to reflect on the labours of their more enthusiastic confrères as a little Quixotic, they may derive consolation from the abundant counterparts that serve to keep them in countenance, in the past history of archæological research in older corners of the world. Nor has their labour been in vain. Their diligence has gone far to prove that no such relics as they sought for are to be found ; and that if Icelandic and Norse rovers, or far older Egyptian, Phœnician, Greek, or Punic adventurers, ever landed, by choice or chance, on the American shores, they have left no memorials of their premature glimpses of the Western Hemisphere ; and appear to have made no permanent settlements on its soil.

ON ERRATA RECEPTA, WRITTEN AND SPOKEN.

BY THE REV. DR. SCADDING,
LIBRARIAN OF THE CANADIAN INSTITUTE.

(*Continued from page* 153.)

III. FOREIGN WORDS ANGLICISED.

1. *Anglicised French Words.*

French Canadians, on straying westward into the Upper Canadian settlements, used in former days sometimes to anglicise their names. There are persons in Toronto, I think, now bearing the names of Bishop and Walker whose fathers were respectively called L'Evêque and Marchant. In imagining, in the latter case,—doubtless from the sound,—that *Marchant* was the participle of *marcher*, there was an inadvertent return to the root-notion of *marcher*—which is *mercari*—to go about on commercial errands—like the venturesome trader of Horace,—

> "Impiger extremos *currit* mercator ad Indos."

Were the forefathers of any of our Cowpers, Coupers or Coopers, *col-porteurs—impigri mercatores* with a tray of wares suspended from their necks (*cols*) ? (Comp. *coup* from *colpo*)—There was once also settled here a clever French machinist who, probably by some happy mistake, bore the fine Latinized cognomen *Columbus*.

In the familiar word *shanty*, from *chantier*, we have confounded the timber-yard with its "office"—the log-covered area of the first clearing in the forest, with the temporary hut for the shelter of the chopper;—for *chantier* is properly not a house at all, but an enclosure where logs are piled.—Again, we call the little wicket for air in our outer winter-windows, a *tiret*, even when it opens upon hinges, the term implying a *slide*.—"Concession," as applied by us to the subdivisions of a township, implies no longer what it did in the old Lower Canadian feudal phraseology in which it originated. There, it was the grant by the King of a seignorial domain for the tenure of which certain acts of fealty and homage were to be performed, "pursuant to the custom of Paris."—In referring to the Speaker of the House of Assembly, as *M. l'Orateur*, we have to modify a good deal our English notion of *orator*, freedom from rhetorical flourish and

silence itself being official characteristics in that functionary. We have this use of *orator* in connexion with one of the English Universities—where "Public Orator" denotes simply the organ or mouthpiece of the corporation; but in this case, eloquence, or at all events, rhetoric art, the one allowably, the other generally of necessity, is associated with the title.

Our Canadian term *portage* requires a little interpretation. In an Article on Prof. Hind's work on Labrador it is evident that the English reviewer stumbled at first at this expression. He doubted as to whether it was not Labrador for a certain measure of length, somewhat as *parasang* is Persian for three or four miles.—The word *traverse*, in the language of our Canadian boatmen, has likewise a meaning which is to a certain extent special, and in this application has given names to some localities, as, for example, Great Traverse Bay in Lake Michigan.—It is to be feared that our *Sable Islands* and *Points Sable* —which of course simply bespeak their own arenaceous character—sometimes convey to the English mind the notion that a certain valuable fur, met with only in Siberia, is among our peltries. Just as in the well-known Cornish "Perranzabulo" some have fancied they have discovered a Hebrew element, instead of reading in it, as they ought to have done, *Peranus in sabulo*—"St. Peran's in the Sand."

"Bureau" is, in one respect, a kind of border word, being familiar throughout Canada as a term for a Public Office—a sense in which it is not popularly known in England. It usually denotes there, as it does also here, a convenient article of household furniture. Its strict signification, however, is the Table covered with a tapis of rough drugget (*bure*) at which officials are supposed to transact business. It thus corresponds to our "Board" as applied to a body of Directors. In a somewhat similar manner, *toilette*—which describes now with us, alike the act of dressing and the dress, is in reality only the *toile*—the cover thrown over the dressing table. "Bonnet," again, is the name of a material used in the decoration or needful protection of the head—applied at length to denote the head-covering itself; just as *castor* and *beaver* have come to signify "hat." "Frock" also (Gallicè *froc*), is the name of a coarse fabric in wool (*floccus*), of which especially, the characteristic "frock" of the monk was made.

Our word "Map" presents another allied instance of metonymy. This is properly the French *mappe*, an old word for *napkin* A chart of the world exhibited, when outspread, the regular folds of a newly-

spread napkin; hence the term *mappa mundi* was applied to it, and hence has come the term applied by us to that and all lesser geographical delineations.—*Mappe,* by a not uncommon change of *m* into *n,* has become in later French *nappe,* whence again has not only sprung our diminutive *napkin,* but,—by a singular aphæresis, arising from the influence of our indefinite article "an" before a vowel—the English word *apron* also, which is, in strict propriety, a *napperon*—that is, a small napkin doing pinafore duty.* Apropos also of vestments and their material, we may here notice *surplice.* This is *sur-pelisse,* something thrown over the *vestis pellicea,* the fur-lined and more closely-fitting undergarment. With *-plice* for *pelisse* we may compare *plush* for *peluche*—a derivative not of *pellis,* but of *pilus*—whence also an English word *pile* in the sense of *nap,* &c.

The uncouth Americanism "Fillibuster" may have occasioned us some perplexity. It has arisen from the equally uncouth French *flibustier;* and this is said to have sprung from *flibot,* the French rendering of the Low Dutch *vlieboot,* which in plain English is *fly-boat*—a small vessel built for speed.

In writing down, as we do, a certain vessel of war, a "frigate," employing in the first syllable an *i,* we have perhaps unconsciously recovered the stem-vowel of the original word, this being *fabricata,* a structure—a *bâtiment,* as the French still call a large ship; but in so doing we depart from the orthography of the nations from whom we borrowed the term. The Italians and Spaniards say *fregata,* the French *frégate.*

Our *canoe* is the French *canot,* and is imagined, I believe, by some to be an Indian word for boat. (This in Ojibway at least is tchiman.) Its source is, however, European. *Canna* for *boat* is a very ancient term. Juvenal speaks of the African *canna* as having a peculiarly sharp prow. He is referring to a certain Numidian oil used in the Baths, "quod," he says—

"Canna Micipsarum prorâ subvexit acutâ."

An old French word for *boat* is *cane,* whence *canard.* The root is

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* Mistakes in regard to articles have occasioned many changes in words. From *lynx* came the Italian *lonza.* The initial *l* sounding like the elided article, it dropped off from the French *once,* whence we get our *ounce,* as the name of an animal. By a like process *azure* has arisen out of the Persian *lazurd.* In *lapis lazuli* the *l* has survived. Out of *lingot,* a derivative of *lingua,* we have made *ingot.* On the other hand, the bird which we correctly call the *oriole* (aureolus) the French by some caprice call *le lorioe.—Lierre* is *l'hierre* (*hedera,* ivy.)

canna, the cane or bamboo, one species of which (*bambus arundinacea*) grows to the height of sixty feet. So long ago as the time of Herodotus it was reported that on the Indus, the nations caught fish in boats made of reeds, each formed out of a single joint. (Herod. iii. 98.)

In saying *Engineer*, how unwittingly we drop out of the word almost all its nobleness! By it we transfer to the English mind but poorly the grand hint given in *Ingénieur*, that here is a man whose speciality is *ingenium*—brain!

This suggests to us that *Artillery* is to be interpreted in a similar manner, as denoting all *Engines* of war—the mechanical results of the application of the highest *art* and skill. It may here be not inappropriately added that *atelier*, the workshop, is thought, on good authority, to be also connected with *ars*, *astillaria*, i.e., *artillaria*, denoting, in late Latin, implements for every purpose, of peace as well as war.

Our word *redoubt*, to denote a certain part of a fortification, exhibits a *b*. We either seem to have supposed that the French *redout* was from *redouter* (redubitare), and not from *ridotto* (Lat. *reductus*) a retired place; or some of our gallant soldiers, on being received rather too sharply before such an outwork, and deciding to take second thoughts about the mode of attack, have good humouredly taken the name of the impediment to express their own hesitancy on the occasion; just as their impetuous Australian brethren have named for an obvious reason, a troublesome thorn in their woods a *wait-a-bit*.

This *ridotto* or *reductus* lies concealed also in *rout*, when it signifies a grand "party:" this is properly *réduite*, a hall for public amusements; whilst *rout*, a flight, and *rout*, in such an expression as *rabble-rout*, is *rupta*—whence also *route*, a road. In this last acceptation, *rupta* is a graphic term to us, who are familiar with the processes by which roads are first made, and at length perfected, in a new country.

The French form of the name of our James the First—only *à l'Anglaise* corrupted—is concealed in the title of one of our national flags —the "Union Jack." It is as difficult to say why we have made *Jack* the familiar sobriquet of John, as to explain how we have formed *James* out of *Jacobus*. From its pronunciation, *I-a-cob*, we see how the Spanish *Iago* and *Diego* have arisen.—We are not responsible for the conversion of *St. Macarius's* name into *Macaber*, in the popular mediæval pageant of the *Danse-Macabre*. Some etymologist in the court of James might have been suspected of the act.

A difficult word is supplanting *légèrité de main*, viz., *prestidigitation*. If it survives, it is likely, like its synonym, to undergo mutilation. Already *prestigiateur* is common in the Papers. But this is not bad, provided it be understandingly used. It is, in its etymology, an entirely different word from *prestidigitateur*.*

Curfew (*couvre-feu*), kerchief (*couvre-chef*) and vinegar (*vin-aigre*), are examples of our *errata*, in French, so trite that we make no remarks upon them. But one word in connection with *purée*, which emerges now and then in the Papers. A reporter, for example, was lately prosecuted, and successfully, by the restaurateur of a railway-station, for stating in print that his (the said restaurateur's) soup was a wretched *purée* of horse-beans. This word we have already in the language, only we have anglicised it into *porridge*. In this familiar form it comes nearer than even *purée* to the root—qu. bulb?—of the word, viz., *porrum*, leek.

A consideration of *pourchasser*, the French form of our "purchase," throws light on the curious use of this expression, not only for the act of buying, but to designate an acquisition of mechanical power or advantage. Our pursuit of an object—our aiming even at a mechanical effect—is a "chase" in which we are engaged. The gain of strength which we desire to describe by the term is a help—a lift onwards—towards our quarry.

Who would believe that *hatchment* was *achievement?* Our *achievements* are the great and good deeds which we have accomplished—brought *à bout*—conducted *à chef*, to a head—to a good issue, and which are supposed to be worthy of emblazonment on our shield of arms, whilst our actions of a contrary tendency are described as *meschefs* (*méchefs*)—non-fulfilments of our proper destiny—*mischievous* failures in duty.

It does not sound very Parisian to say of any body that he is all agog, or of any thing that it is all the go; yet we have here, disguised, the not dissimilar expressions—both perhaps having *gaudium* at bottom—*être à gogo*, *tout de go*. Anglo-gallicisms such as these are by no means uncommon. We have turned *sieur* (senior) into *sir; panse* (pantex) into *paunch; tortue* (tortuca) into *turtle; accise* (late Latin *accisiae*) into *excise; créanter* (*créance*, *fides*) into *grant; autruche*

* The one is from the Late Latin *praestus* (Ital. *presto*), and *digitus;* the other from *praestigiator* (a juggler), occurring in Plautus; and this from *praestigiae* (sleights, signs, &c.), whence *prestige*.

(*avis struthio*) into *ostrich*, &c. &c. From *patron* (patronus) we have formed *pattern*. Out of *s'essorer* (exaurare) we have developed *soar*. The *bassinetts* which we see advertised are *Barcelonettes*. *Jais* we have converted into *jet*, intending, it is probable, at first, that the *t* should be silent. In this case we have certainly obtained a very simple vocable out of a rather unpromising-looking original, viz., *gagates*, *gag'tes*.

Tante we have transformed to *aunt*, thereby accidentally approaching the original *amte*, i.e., *amita*, *am'ta*. We have rejected the initial *t*, which—as in *a-t-il*—was an intercalation to prevent hiatus, the full form having once been *ma-t-ante*. Of *frère* we have made *friar*, from which has evaporated the notion of *brother*.* *Pape*, which has a fragment of sense in it, we write *pope*, which has not. *Messe* we call *mass*, departing still farther than our authorities from *missa*. (*Ite catechumeni! concio missa est.*) *Mets* we write *mess*, a departure again from *missa*—but now *missa* is neut. plur., denoting the things *sent* to the table. To *prowess* we attach the idea, I think, merely of might combined with courage; in *prouesse* is implied the *prudence*, or the *prov*-ed experience of the *preux chevalier*.—Dropping out of *tailor* one of the *l*'s of *tailleur*, we somewhat obscure the notion of *cutting* which would otherwise be suggested from our familiarity with the cognizance of the well-known publisher, Talboys—a hatchet struck into a tree-trunk, accompanied by the legend *Taille-bois*.—The first syllable of *comrade* has been forced by us to be a symbol of fellowship, by a violence to *camarade*, which indeed denotes companionship, but specifically that of a chum or *chamber*-fellow.†

We say *balance* for the complement or difference between two amounts. It should be *bilan*, a curious technicality in French book-keeping derived from *bilanx*—Latin for a pair of *lances*, i.e., dishes or *scales*.—It is likely that the Englishman who first transferred the French *limon* to our language intended that we would pronounce it *le-mon*, as he wrote it. At the same time it may be remarked as strange that the Frenchman who first heard the name of the Arab fruit, *laimûn*, should have jotted it down *limon*.

Sangraal figures in our story of King Arthur. *Holy grail* has

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* *Elbow*. * * * Bless you, good father friar.
Duke. And you, good brother father.

—*M. for M.*, iii. 2

† In Fanshaw's Translation (1655) of *The Lusiad*, we have *cam'rade*. (Vide vii. 25.)

been made out of it, suggestive of nothing etymologically, but associated with the *santo catino* at Genoa—a bowl supposed to consist of a gigantic gem of inestimable worth, until the audacious French savans showed it to be nothing but common glass. The true form of the word is of course *sang-réel.*

We might pass over *sugar* without remark, as every one knows that it is the French *sucre,* which is the Arabic *sikkar* or *assikkar*—an old word, appearing also in the Greek *σάκχαρον.* But our *candy* (the French *candi*) is not generally debited so correctly. This is sometimes supposed—like *candidus*—to be derived from *candere,* to be white; it is in reality, however, oriental likewise—first, Arabic *gand,* the sap of the sugar-cane brought to a viscous state; and this, secondly, is the Hindoo *khanda,* a morsel—i.e., sugar in small crystals or morsels.

Coterie, which is properly a club in which each one pays his *quota* (to be pronounced *cota*) or scot, is now a "set"—a restricted circle of co-notionists. Under some circumstances it becomes a *clique*—a union for sensation-purposes—a combination to raise a *clack* either for or against a given measure or man.

In theory *pic-nic* has taken the place of *coterie* in its etymological sense, suggesting an *al-fresco* regale on cold fowl or similar contributed viands. A *Pic-nic,* however, in its primary association, was something much more *spirituel.* It appears to have been a sort of tournament of wit—a gentle passage of repartees—of retorts courteous and polite;—an encounter in which "*tu me piques, je te nique*"—*tit-for-tat*—was the motto.

We use the word *billet* to express a little note. Why do we apply the same term to a thing so dissimilar as a piece of cleft wood? By a now forgotten inaccuracy. The billet of wood in French is not *billet,* but *billot*—an allusion perhaps to the instrument by which it was cut or cleft; while *billet,* the letter, speaks of the *bulla* or seal, which was appended to it to attest its genuineness. *Bulletin* is a farther diminutive of the same word. Our English term *bill* has no connexion with this. *Bills,* as we have already seen, (p. 151), parliamentary and domestic, are properly *li-belli;* whence also our *libel,* the schedule in a Court of Justice detailing the charges against a man being put, by a metonymy, for the charges themselves. These must happily or unhappily have been so often proved groundless, that the

word at length has become invested, in ordinary language, with its present evil significance.

In writing *moiety* for *moitié* we have perpetrated another Anglo-gallicism; but we have retained the derivative meaning of the word, viz., *medietas*, i.e., half.—Out of *pieté* we have made *pity*, and assigned a new sense to the term, introducing, however, besides, the original in its proper sense.—*Proprieté* we have treated in a similar manner; only, to the blundered form *property* we allow the right sense of its original, viz., ownership, whilst to *propriety*, the later and purer word, we assign a sense quite novel.

Through some misapprehension, perhaps, at the moment of first hearing, *rivière* has been converted into *river*, although it is really the river's bank (*ripa*) and not the stream. So with us, *grap* has become *grape*, although *grap* is the bunch and not the berry (*raisin*).

Vignettes now seldom exhibit what *vignette* manifestly implies; nor are *miniatures* any longer little sketches in vermillion (*minium*), any more than the rules commonly called *rubrics* are necessarily things of red-letter.

Promenade we confine to an exhibition of ourselves on foot. In the Bois de Boulogne it is equally said of horseback or carriage airings. The connexion of *voyage* with *via* might suggest travel by land as well as by sea. To the latter however—in modern English at least—we have chosen to restrict the application of the term.*

In the United States the word *trait* has become English. This jars upon our ears. The people of Plymouth in Devonshire have made out of *Haut, Hoe* (i.e., if the latter be not indeed *Hoo* or *How*.) It is almost a pity, since *trait* is to continue French in sound, that we have not in some way manipulated it into English form.†—The same thing may be said of *dépôt*—which among the mixed multitude on the railway platform suffers violence in several ways.

We appear to have formed our familiar term *Helot* by phonetically writing down the corresponding French *Ilote*, which we do not, from its appearance, readily recognize as the same word. So, however, it is. In Livy (34, 27, 9,) also, we find Εἵλωτες represented by *Ilotae*, and Philemon Holland, in his translation of Plutarch's *Morals* (p. 469, ed. 1603), speaks of "Ilotes." *Ilote*, it will be noticed, is

* Dryden employs *voyage* in the general sense. Thus he makes the Sibyl say to Aeneas in Tartarus, "Let us haste our voyage to pursue." (See Aen. vi.)

† Bacon has "by the *tracts* of his countenance." See Essay vi.

written without the initial aspirate which it ought to have.—This is better than writing it and not in practice using it, as is so extensively done in French.—Query, Are we in any way to attribute to this French usage, the ignoring of *h*'s, which is so much laughed at in England?—Less just to this sound than the persons ridiculed, the French do not, I believe, in any case insert it where it is not. This is what—influenced perhaps by a notion of connexion with *hostis*—we have done in the case of *hostage*—which properly is *ostage*, Old French for the same thing, derived through *obsidiatus* (the act of giving a hostage) from *obses*.*

Has the expression "to blaze," as applied by surveyors to the marking of trees when running "lines" through a forest, arisen from a corruption of *briser*, technically used in this sense, as in the expression *marcher sur les brisées de quelqu'un?*

Is not "to stump," as a synonym of "to pose, confound, and nonplus," simply *estommir*, which denotes very much the same process? And has "mooning," in such a phrase as "mooning along," descriptive of a habit especially of short sighted persons who wear *spectacles*—anything to do with *lunettes*?

(*To be continued.*)

ADDENDA TO SECTION II., p. 147.

1. Further examples of literal abbreviations.—N. or M. is N. or NN. (*nomen* or *nomina*). M has arisen from the two N's as W from two U's.—O. P. (Old Price, i.e., the former price of the tickets).—U. E. (United Empire).—F. E. R. T. (on the shield of Sardinia) is, not *Fortitudo ejus Rhodum tenuit*, but *Foedere et Religione tenemur.*

2. Do. of abridged words.—*Par. affin.* (i.e., *parum affinis.*)—*aroph*—(*aro*[*ma*] *ph*[*ilosophorum*].)—*Aur. pigment.* (*auri pigmentum, orpiment*).

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* The vagaries of the old so-called etymologists in their efforts to derive everything from the two or three ancient languages of which they had a very imperfect knowledge, are sufficiently amusing. One of them derives *rat* from *mus* thus: *mus* (*muris*), *muratus, ratus, rat.* Another, for *barde* (horse-armour), suggests *cooperta, cooparta, parta, barta, barde.* Another deduces *haricot* from *faba*: *faba, fabarius, fabaricus, fabaricotus, faricotus, haricotus, haricot.* By a like Darwinian process *larigot*, a musical instrument, hails from *fistula: fistula, fistularis, fistularicus, laricus, laricotus, larigot.*—But the following are legitimate: *operire*, to shut; *de-operire*, to open; hence *dub-rir, adubrir, aubrir, ouvrir.*—*Æqualificare, égalifier, égalger, egauger, gauger*, to gauge.—*Octroi*, the tax levied by the "Authorities" on the necessaries of life as they pass within the city-gates, has its rise in *auctoricare, auctorare. Ennui* = *in odio*,—the complete phrase being *est mihi in odio.*

3. Do. of words suffering apocope.—*Squad* (from *squadron*), *coz* (from *cousin*), *plenipo, photo, typo, pill* (for *pilula*), *barb* (horse of *Barbary*), *brig* (*brigantine*), *prim* (*primitive*), *alum* (*alumen*), *ipicac* (*ipicacuanha*), *joe* (*Johannes*, a Portugese coin), *sol* (i.e., *sou*, for *solidus*), *ink* (for *inch-iostro*, Ital., *encaustum*, Lat.), *buff* (from buffalo-leather), *post obit* (*post obitum*), *Punch* (from *Punchinello*—and this from *Puccio d'Aniello*, the inventor of the character).

4. Do. of words formed by an aphæresis.—*Tram* (in *tramway*) from *Ou-tram; spite* from *despite; pose* from *appose; cess* from *assess; uncle* from *av-unculus; pert* from *malapert; doll* from *idol; moist* from *hu-mectus; age* (from *Old Fr. ed-age*, a derivative through *aetaticum*, of *aetas*); *plot* from Fr. *complot; megrim* from *he-micranium; lammas* from *ad vincu-la mass; Masaniello* from *Tom-mas' Aniello; Cola di Rienzi* from *Ni-cola di R.*, &c.

5. Do. of words arising from agglutination of the article or a preposition, or omission of apostrophe.—*Lisle, Lorient, Labbe, Doria, Townsend, Wallsend, Daisy, gendarm, marsh* (*marish*), &c. Comp. *aguilaneu* (=*à qui l'an neuf.*)

ON SECLUDED TRIBES OF UNCIVILIZED MEN.

BY DAVID TUCKER, M.B., B.A., T.C.D., ETC.

We are accustomed to group the whole human family into three grand divisions, which we severally style civilized, semi-civilized, and savage. However convenient this division may be for ordinary purposes, it is by no means philosophical or exact. As Horace experienced a difficulty in finding a line which should separate the sane from the insane, so should we be at a loss to discover the point at which civilization begins to merge into barbarism. The truth is, that, from the most highly organized and civilized member of the Aryan family, down to the most degraded and ferocious savage, there is a gradual and gentle descent. All who are styled savages are not equally savage. Many uncivilized tribes have made considerable advances in what we are accustomed to call the arts of civilization be-

fore they have had opportunities of intercourse with civilized men. Some who have bordered on the dwellings of the civilized have evinced a superior aptitude for learning the uses of certain mechanical appliances, and, though still continuing savages, have appropriated the inventions of civilization for the better prosecution of their savage practices. Several such tribes, as, for example, the Maoris, have proved themselves formidable antagonists to those who have possessed all the advantages of a high civilization; and this has been to a great extent brought about by their adopting the implements and practices of warfare as used by civilized men. Other savages are differently affected by the inroads of civilization upon their borders. The native Australian is endowed with a sort of pacific confidence in his intercourse with the civilized races. He frequently visits the settlements, but, being of a low type, as regards intellectual power, he does not avail himself of the superior arts of the civilized man for his own aggrandizement, yet can improve, by culture, in mental capabilities. But even in the abyss of barbarism itself, there are degrees. Some tribes are apparently of so low a standard of intellect that they evince no disposition to form those social bonds which other men, even in the savage state, generally adopt for their commou welfare, or to profit by the opportunities afforded them of intercourse with superior races.

It is a very interesting fact that there exist, scattered throughout the world, several detached, though, in general, inconsiderable bodies of men, who have secluded themselves from intercourse with the rest of their species, in a most determined manner. Whatever communication they have had either with other wild tribes or with civilized men, has, for the most part, been forced upon them. Such has been their habit of life from the earliest times of which we have any record of their existence. In the case of some of these tribes a probable cause has been adduced for this secluded condition; and their early history, interwoven with mythical narrations, has been referred to in proof of their having been a fragment of a more considerable body broken off by persecution or separated by migration from the original mass. Although such tribes are to be found in different regions and climates, yet in their habits, characteristics and persons there is a general resemblance. For example, a majority of them are to be found in regions which are very scantily supplied with the means of supporting animal life. They are consequently, through

want of generous and regularly supplied nutrition, stunted in their physical development. In the children, particularly, alternate starvation and repletion produce an abnormal development and distension of the abdomen. The limbs, on the contrary, appear almost devoid of muscle. They are all filthy in their habits and unscrupulous as to the disgusting nature of their food, many eating insects and other vermin with avidity, though one known tribe, at least, refrains from certain kinds of wholesome flesh. In the construction of their dwellings and couches, which may with more propriety be termed dens and lairs, they approximate to the habits of the lower animals. Like most of the carnivora, they appear to have nothing gregarious in their nature. Sometimes a few families are to be found in the same district, but each has its own solitary abode. As might be expected they are wild and shy, often running at the approach of a stranger. Some are cruel and vindictive, others mild and harmless. In general they have hardly any tradition, an apparently imperfect language, and but vague ideas concerning the existence of spiritual beings.

In examining these characteristics it is exceedingly difficult to distinguish cause from effect. We may, of course, reasonably conclude that dietetic influences may produce unshapeliness of form; gorging, to an extent unknown amongst civilized men, distending the abdomen without permitting the due assimilation of the ingesta for the development of tissue. The nutrition of muscle would also be wanting in seasons of famine which with such people are exceedingly common, or, indeed, we might say that starvation with them is the rule and repletion the exception. The natural result of this deficiency and irregularity in diet would be an incomplete development and a deformed aspect. But concerning other peculiarities of their position and character there are several obvious questions which may be propounded, and which are not easy of solution. For example, as the majority of known secluded tribes dwell in sterile regions, is it their habitat which degrades the men, or is it their naturally degraded character which depresses their desires to so low a point that they long for nothing better? Is a love of seclusion a natural and innate characteristic of these tribes in contradistinction to the gregarious nature of other men, or has the accident of their seclusion engrafted that nature secondarily upon them? Has that seclusion been the chief cause of their present degradation? If fortuitous circumstances have originally caused their segregation from a large body of men, how is

it that no tradition of a region more abundantly supplied with the means of supporting animal life has stimulated them to migrate to a more favoured locality? With still more surprise may we ask how it is that some of these tribes when even but a short distance removed from the settlements of civilized men, appear content with their degraded and miserable lot, seeking no intercourse with or assistance from their more favoured neighbours? What is the cause of their persistent and determined seclusion? Is it natural ferocity and hatred towards all mankind? Is it an inherent timidity of character? Or is it a mere stolidity and incuriosity, the result of their degraded intellectual condition?

Such questions are more easily propounded than satisfactorily answered. Probably none of them, in our present state of ethnological and anthropological knowledge, can be thoroughly solved. But it is reasonable to suppose that the most direct way towards a solution of these will be an examination of the actual condition, character, habits, and (if possible) history of the tribes in question. As our time is limited, it will, of course, be impracticable for us to examine into such circumstances in connection with all known secluded tribes. I shall, therefore, in order to stimulate investigation and elicit opinions upon this important subject, give slight sketches of two of these segregated tribes, whose condition and history are peculiarly interesting. One of these tribes is of the vindictive and ferocious class: the other is of the mild and inoffensive. One resides on a group of sterile islands; the other in a region of great fertility.

The first of these tribes to which I shall call attention is found upon the Andaman Islands, lying on the eastern side of the Bay of Bengal. The people who compose this tribe are, in more ways than one, ethnological curiosities. In the first place, they are not of that Turanian family, to be found in their vicinity on the main-land, but of that dark-skinned race with frizzly hair, known formerly as the Negrillos, or Negritos, but now termed Melanesians. The great puzzle in their case is, how they became isolated from the rest of their race, and chanced to take up their residence upon these islands. There have been several wild conjectures upon this subject, on the supposition that they were of the same stock as the African Negro. It was supposed that a Portuguese slave-vessel had been wrecked upon the islands, and the crew murdered, the slaves landing and establishing themselves as lords of the soil. But this, as well as

another unauthenticated account of a similar fate happening to an Arabian ship, with like result, cannot be received. The former, indeed, must be an anachronism, as these islanders are mentioned by Ptolemy. The same race is to be found in the mountainous parts of the Malayan peninsula, under the name of Samangs or Semangs, and it is conjectured that these Melanesians once held the whole of that peninsula. If such were the case, we might account for the presence of the same race in the Andaman Islands, by supposing that a small section, perhaps guilty of treasonable or other reprehensible conduct, had been sent adrift or banished to these islands. Most probably the original home of this race was in some of the Oceanic islands. It is a curious coincidence that the inhabitants of the Andamans, and the Fijis, who are also of the Melanesian race, have both adopted the same custom in dressing their hair, namely, colouring it a reddish-brown with some ochreous earth. The character and habits of these people are also very extraordinary. They are exceedingly shy of strangers, but will occasionally, on provocation, turn upon them with great ferocity. Hospitality is certainly not one of their virtues, and it is extraordinary that they bear the same animosity to all races of men, white and black. It will be recollected that it was to one of these islands the King of Delhi was banished by the British. There was also a stronghold on one of them in which several rebel Sepoys were imprisoned. Some of these succeeded in making their escape. So unfriendly was the reception which they met with at the hands of the natives, that the majority of them were exceedingly glad to return to imprisonment. A few never returned, and were supposed to have perished by the violence of the inhabitants or by hunger. Two girls were once found on the beach in a state of starvation. The boat's crew that found them, enticed them by the sight of food to come near. They took them on board ship, attended to their wants, and treated them with great consideration. Their conduct on board was shy and suspicious. They would not both sleep at the same time; one always kept watch whilst the other reposed. When they had recovered their strength, and the ship approached within half a mile of one of the islands, they slipped into the sea by night and swam ashore.

As regards their personal appearance, it is such as we might expect, knowing their position and their race. Their stature corresponds with the usual stature of secluded savages—five feet in the case of males, and four in that of females. These islands not being

blessed with the cocoa-palm of the continent, and being in other respects extremely unfertile, with hardly any quadrupeds existing upon it, the inhabitants are often driven to straits, and pick up their living to a great extent by traversing the sands and mud-banks in search of shell-fish. An inspection of their feet would have delighted the heart of Lamarck, whose development theory was that the necessities of existence cause new developments of organs—*rasores* being supplied with long and strong claws when they discovered that their circumstances obliged them to scratch, and *natatores*, by the continual expansion of their digits, being supplied with webs when they found that they must swim for a living. So the Andaman Islander has, at the present day, a foot most admirably adapted to his position and labours on the yielding soil of the sea-coast. The foot is exceedingly large, and the os calcis so greatly exaggerated and projecting posteriorly, that, favoured still further by the lightness of his body, he can safely traverse surfaces into which an ordinary mortal would sink. His cranial type is not by any means low. These people have the usual spindle-shanks of ill-developed men, but the length of the limbs is proportionate to that of the body. Their couches are like the lairs of the Bushmen. They do not trouble themselves with any clothing, and they have a community of wives. Professor Owen regards them as at the lowest point in the scale of humanity. He states that they have no notion of a Deity, of a future state, or of spiritual beings. But this assertion, as Mr. Bruce very justly remarks, is not easily proved. We usually find that the most degraded savages have some idea of the existence of spirits good or bad. At a meeting of a scientific society lately held in Sydney, I perceive, by the report of proceedings, a similar assertion made concerning some of the Australian aborigines was stoutly denied upon good authority.

The Andaman Islanders are a comparatively ancient tribe. They are stated by Ptolemy to be cannibals, but this charge, though repeated by Marco Polo, and by so eminent an authority as Dr. Latham, has been found to be incorrect. They may, as has been the case with other tribes, even of superior races, been driven to cannibalism on a rare occasion, through danger of imminent starvation, but the eating of human flesh is not their regular practice. The population is about two thousand, and is kept down by checks as severe as even Malthus himself could desire. They have no regular social organization, but live in gangs.

We may naturally inquire what can be the cause of their determined isolation, wildness, and untameable ferocity. The most reasonable solution of the difficulty is merely a conjecture. We surmise that those who first planted the colony must have experienced cruelty, at the hands either of their own or some other race of men. It is possible that the stock may have originally migrated from the Melanesian islands of Oceanica, and gained a footing in the Malayan peninsula, whence they may have been driven under circumstances of cruelty. They attack Malays with as much ferocity as they do Europeans. Another section of the race may have taken refuge in the mountain fastnesses of the peninsula itself, where it exists at the present day, as formerly mentioned, under the name of Samangs or Semangs. I cannot find that there have been any opportunities of forming further conjectures from the language of these strange people.

Another secluded tribe to which I shall refer is to be found in the island of Ceylon; and I must confess that it was in order to correct some current errors and to bring some recent information concerning it before the Institute, that I selected the subject of this paper. Ceylon, from the various vicissitudes of its history and from its having been the resort of merchants through a long succession of ages, presents an interesting object of study to the ethnologist. At the present day there are to be found there, especially in the seaports, representatives of at least three, and probably of all, of the great human families. The Aryan, or Indo-European is represented by the British, Dutch and Portuguese, or their descendants; the Semitic by the Moormen, or traders of the island, who are really Arabian in origin; and the Turanian, which is the family to which those called Malabars belong, who are identical with the Damilos or Tamils, a race that migrated at an early period from southern India to Ceylon. In addition to these there are specimens of other races whose connection with any one of the great families ethnologists cannot as yet trace, such as the Kaffirs and the Chinese.

The aboriginal inhabitants of Ceylon are supposed to have been of the Malay race. But there are no reliable records on which to base such a supposition. The character of the canoes which are to this day to be seen on the coast has been adduced as a proof of this assertion. These are supplied with that peculiar appendage styled an "outrigger," which appears in all countries where Malayans

have settled, and is not to be found on the Arabian side of India. It is probable that whether any traces of the Malay type can be discovered, as some suppose, in the personal appearance of the native population or not, that the country was originally settled by tribes similar to those which at a remote period colonized the Dekkan. These aborigines had, however, to retire before a more powerful race about 543 years before the Christian era. At that time they were called "Yakkos" and "Nagas;" which literally signify "demons" and "snakes." They were so termed, it is supposed, by neighbouring tribes contemptuously, from the circumstance of these aborigines being divided into two classes, one of which was addicted to the worship of demons, and the other to that of the cobra, as an emblem of destroying power. In 543 B.C. Wijaya, a prince from the valley of the Ganges, who had got into bad repute at home, landed with a number of followers near Putlam, and established a dynasty which lasted for several centuries. This invasion was followed by an influx of Malabars or Tamils, who ultimately gained possession of the island. They were driven thence in 1071, A.D., but again returned and established themselves in 1211. In 1266 another invasion took place, this time from the Malayan peninsula, and was followed by fresh incursions from the coast of India. In the fifteenth century the island was visited by the Chinese, with hostile intent, and the celebrated commander, Ching Ho, attacked the capital and carried off the king into captivity. For several years after this, Ceylon paid a yearly tribute to China. The Portuguese were the next visitors. They first landed in 1505. In 1597 the King of Cotta died, and left the King of Portugal heir to his crown. In 1617 the Portuguese took Jaffna, and assumed the command of the country. After the Portuguese the Dutch became masters of the island. The first Dutch ship arrived at the island in 1602. The Dutch contended with the Portuguese for 20 years, finally prevailing against them. In 1795 the British united with the Kandyans to expel the Dutch from the island, and in the following year Ceylon came into the possession of of England.

A country, therefore, which has been the scene of so many invasions, which has changed masters so many times, and which, from its fertility, has been an attraction to merchants from all parts of the globe, it is said, even since the days of Solomon, must present a mixture and a variety of human beings well worthy of the study of

scientific men. None of the other races, however, specimens of which abound in the island, possess an equal interest for the philosophic mind with the despised and degraded remnant of the aborigines who are styled "the wild hunters" of Ceylon. This wretched race has existed in a state of comparative seclusion for 2000 years, retaining during that time its ancient habits, customs, superstitions and modes of life. These people have no proper distinctive appellation, being merely called "Veddahs," which term in India is applied to hunters generally. They inhabit extensive districts which are called "Widdirata," or country of Veddahs. It so happens that the history of those extraordinary people can be traced with considerable precision. Ceylon is fortunate in having records of its early history on which some reliance can be placed. Among the earliest notices we have of the existence of Ceylon we may mention the Hindoo Ramayana, one of the oldest epics in existence. In this work the island, under the Sanscrit name of *Lanka*, figured conspicuously. In perusing this, however, we must make great allowance for poetical exaggerations and invention. But there is in existence another very important work, a record of the history of Ceylon from the landing of Wijaya in 543 B.C., down to the year 1758 of our era. This work, which is called Mahawanso, or "Genealogy of the great," was discovered in the year 1826. It was written in the Pali tongue, a classical form in ancient Behar of a modification of Sanscrit speech which is to be found in the Hindoo drama. Mr. Turnour, of the civil service in Ceylon, has translated a large portion of the work. This was a difficult task, as the Pali was a language known only to the Buddhist priests, and imperfectly by them in Turnour's time. The history was written in verse, and, in order to render it more intelligible, there accompanied it a *tika*, or running commentary in prose, probably resembling the *interpretatio* of the old Delphic editions of the Latin classics. This was a great assistance to the translator in his arduous undertakings. Now in this "genealogy" there are descriptions given of the condition and pursuits of the inhabitants of Lanka, before their conquerors had taught them the art of agriculture; and, strange to say, the condition and pursuits of the modern Veddahs correspond exactly with these descriptions. Pliny in his Natural History, (lib. iv., ch. xxiv.) informs us that the Singhalese envoys, who visited Rome in the time of Claudius, state that it was the custom of their countrymen, when foreign merchants visited

the island, to go to the further side of a river where the strangers had laid their goods, leaving other commodities in their place. The same practice is alluded to by Fa Hian, a Chinese Buddhist, who wrote in the third century. This peculiarity is also recorded by several other writers in succession, until we come to the time of Robert Knox, who published in 1681 an "Historical Relation" of the island, in which he was a captive from 1659 to 1679. From this author we have a good deal of valuable information concerning these tribes, though I believe he wrote from the testimony of others. Dr. John Davy has also contributed some information concerning the Veddahs; and, subsequently, Sir Emerson Tennent has with praiseworthy zeal investigated their history and condition. His testimouy is, however, founded chiefly on report. His opportunities of personal observation were not favourable or numerous, and in the only interview with any of them which he records, he appears to have been misinformed as to the real character of the natives who were brought before him for exhibition. These he himself suspected to be not the genuine troglodyte, or Rock Veddahs, but a partially tamed and partially settled portion of the aborigines, who are distinguished by the appellation of Village Veddahs. This suspicion is confirmed by the testimony of Mr. Bailey, who has written the fullest, most interesting and most reliable account of the Veddahs which I have yet seen, and who distinctly states that those whom Tennent describes were not by any means the wildest description of Veddahs. Mr. Bailey being employed in the civil service in Ceylon, and his duties bringing him into those districts where he could, by personal observation, learn the condition and usages of these wild people, is an excellent authority on the subject which he undertakes to elucidate. His statements do not in all cases correspond with those of Tennent, and in several instances he points out where Tennent must have been misinformed. In fact in reading Tennent's description of the Veddahs, it is almost impossible to avoid being struck with the conviction that there must have been a very high colouring on their part, of the statements made to him by his informants. Probably with these the rule may have been *omne ignotum pro magnifico*, or at least *pro mirifico*.

The Veddahs are divided by Mr. Bailey into the wild and settled ones. It is chiefly on the north-eastern side of the island that these creatures are to be found. They dwell in greatest number in the

neighbourhood of Batticalloa. They are also to be found near Badulla. But in these localities they are not so wild, nor so much isolated as in other parts. The very wildest are to be found in the district of Nilgala and in the forests of Bintenne. If there be any difference between the two, as Mr. Bailey thinks there is, those of Nilgala are the most wild. The settled Veddahs associate with the Singhalese, but do not intermarry with them. They live in huts formed of boughs and bark, when caves cannot be obtained, and cultivate small patches of ground. But their instincts appear to lead them to hunting, and on this they chiefly rely for subsistence. They are also fond of honey, and procure large quantities of it. Efforts have been made for several years to civilize these creatures, and they appear to be gradually losing their wild habits.

Tennent draws a most deplorable picture of the whole race. He states that so degraded are some of these people that it has appeared doubtful in certain cases whether they possess any language whatever—that, on the authority of a gentleman who resided in their vicinity, their dialect is incomprehensible to the Singhalese—that their intercommunication is carried on by signs, grimaces, and guttural sounds unlike words or language—that they have no marriage rites—that the community is too poor to allow polygamy—that they have no knowledge of a God, or of a future state—no prayers or charms, no instinct of worship, except some addiction to ceremonies analogous to devil-worship, in which the performer dances in front of an offering of something eatable. At first he shuffles with his feet to a plaintive air, and then works himself into a paroxysm. Writing of the village Veddahs, he afterwards states that "they have no games, no amusements, no music," which is extraordinary, as he has just informed us previously that the less civilized, or rather totally wild portion, of the race have men amongst them who can dance to a plaintive air.

Many of the above particulars are denied by Mr. Bailey, though even his portrait of these outcasts is melancholy enough. He states that he never knew them at a loss to convey their ideas either to their own fellows, or to the Singhalese. The latter seem to comprehend their language tolerably well. As to marriage rites they have something approaching to a ceremony. The man selects a present, and carries it to the front of the dwelling of his intended father-in-law. The object of the visit being known, the girl, if she accepts him

comes out with a cord of her own twisting, and ties it around the bridegroom's waist. The man always wears the string, and when it wears out the woman twists another. The string is useful for supporting a small dirty rag which hangs in front. This practice appears somewhat analogous to the use of the ring in marriage amongst civilized people. As to polygamy, it is not, according to Mr. Bailey, poverty which prevents its practice, but a complete indisposition on the part of these people to enter into such alliances. That they have no idea of a God, in the light of an individual Supreme Being may be correct, but Mr. Bailey tells us that when it thunders, they say a spirit or a God has cried out, and in one of their invocations the expression "Mâ Deyâ"—My God—actually occurs. To say they have no idea of a future state is almost too much, when they are continually invoking the shades of their departed children. Mr. Bailey relates an instance of a Veddah who aimed a shot from his bow, and having missed the mark, exclaimed in chagrin, "That was because I did not invoke my Belindoo Yakkon!" This expression meant "the shades of his children." They also believe in a host of other spirits either harmless or benignant. They have one malignant spirit only in their mythology, which is supposed to lie in wait for women. It argues an instinct of worship that they fix an arrow in the ground, dance and chaunt around it, promising at the same time native offerings to spiritual beings. They certainly, according to Mr. Bailey, have charms to protect themselves from wild beasts, and if they do not use direct prayers, they are in the habit of invoking the shades of their ancestors, the sun and the moon, and beings of whom they knew nothing but their names, which leads to the supposition that they formerly were connected with a people which had a more systematized religion.

It is exceedingly interesting to recognize in the belief and the usages of these unsophisticated people a striking resemblance to the creeds and customs appertainiug to an early period of society, as recorded in the works of ancient Greece and Rome. It is probable that from the conditions of human existence and the aspirations and passions of the human mind, there must in all cases of primitive society be a resemblance in these respects. The Veddahs attempt to propitiate the *Manes* of their ancestors. They promise votive offerings to those spiritual beings in whose existence they believe, and in the time of sickness present garlands to an imaginary afflict-

ing spirit. They acknowledge also that there are certain phantoms to be met with in the woods or among the rocks—*genii* of rivers and other natural objects. We can scarcely read their statements without reverting to the Oreads and wood-nymphs, to the votive tablets and the garlands of the temples, and to the romantic myths of Numa and Egeria. "The God who cries out when it thunders," is also evidently a counterpart of the Roman Jupiter Tonans.

The physique of the Veddahs is wretched in the extreme. The tallest one which Mr. Bailey had ever seen was five feet three inches in height. He was more civilized than his fellows, and probably had been more favoured in the matter of nutriment. The shortest was four feet one inch. Tennent describes those whom he saw as having projecting mouths, stunted stature, their long black hair and beards falling down to their middle in uncombed lumps, their limbs misshapen and their eyes restless with apprehension. The children had deformed joints, huge heads and "protuberant stomachs." The women were most repulsive in their appearance. The men, he says, were athletic, though deformed, and their heads large. On this last point he formed an erroneous judgment, as the crania of the Veddahs are really small, though the mass of tangled hair which surrounds them exaggerates their actual size. The same error was fallen into by the "Theban traveller," whose experiences are recorded in the treatise *De Moribus Brachmanorum*, supposed to be written by Palladius in, I think, the early part of the fifth century. He calls these people βισάδες, adding the descriptive expressions—ἀνθρωπάρια, κόλοβα, μεγαλοκέφαλα. The skull of a female, twenty-eight years of age, was some time since sent to England. Mr. Busk had an opportunity of examining it, and stated that it was the smallest adult skull he had ever measured. If this skull was a fair specimen, the crania of the Veddahs must be less than those of the Australian, the Esquimaux, or the Negro.

There are several other points on which Tennent and Bailey are at variance. For instance, the former asserts that the Veddahs kill birds by the bow and arrow, and afterwards eat them. Bailey says they are too poor in ability as marksmen to strike a bird, and that they will not eat the flesh of oxen, elephants, bears, leopards, jackals or birds. He certainly acknowledges that they capture birds, with bird-lime, but for what purpose is not, I think, stated. He denies the correctness also of Tennent's statement that the Veddahs occa-

sionally use the feet in drawing the bow. This practice, he states, has long ago been discontinued. Tennent had remarked that money is worthless to them, but Bailey states that he had never known any of them to refuse a rupee.

All, however, who have had any opportunity of judging of the fact agree in stating that their mental capabilities are of the very lowest kind. They cannot count beyond five. A gentleman gave twelve arrows to a head-man of the partially civilized Veddahs to divide equally amongst four families, but he was unable to accomplish the task. They have no names for days, months or years—no system of medicine—no literature, in its lowest sense. Their language is meagre—a sort of obsolete Singhalese, unenriched by Pali or Sanscrit, and supplied with a number of words not to be found in any vocabulary of eastern dialects. The same word expresses a bud and a child. For rice they have no distinctive appellation—it is merely "small, round things."

Morally, their condition is strange. They detest polygamy, polyandry, (common enough among the Singhalese), and incest, save by marriage with a younger sister. But this unnatural custom is becoming obsolete. They are harmless, truthful, and honest; fond of their children, constant to their wives, but jealous. They will not marry out of their own race, and divorce is unknown amongst them, as well as infidelity amongst the wives.

The Veddahs have a great personal resemblance to each other, as might naturally be expected from their alliances. They are not a long-lived race. In a population of 50 adults, only one was found 70 years old, and eight of the age of 50 years. In another of 175, two were found 70 years old, and fourteen of the age of 50. Although there is no infanticide amongst them, large families are almost unknown, and the race is rapidly becoming extinct. There is not much madness, and even less idiocy amongst them; but they are all excessively stupid, and have a very vacant expression of countenance. They claim to be of royal descent, but know nothing of their history, and although they have no caste amongst themselves, the Singhalese regard them as of high extraction. The wildest of them are the fewest in number, and the smallest in stature. Each family lives by itself, and there is an approach to social organization amongst them, as their hunting grounds are apportioned, and the more settled class divide themselves into little communities or septs. The village Ved-

dahs have no intercourse with the wilder branches of the tribe, nor the wilder ones with each other; those, for example, of Bintenne with those of Nilgala, although the places are only about fifty miles apart. But it is observed that the usages and languages of all, however scattered, are similar, arguing, of course, a common origin.

Mr. Bailey's theory as to this origin is exceedingly plausible. Tennent, and I believe most ethnologists, have regarded them as the mere relics of the aborigines who retired before the invaders from the continent. But Bailey considers them, in accordance with their own tradition, and with the respect shown for them by the Singhalese, as really of royal stock. To make his argument clear it is necessary to give a sketch of the early history of Ceylon, intermingled as it is with fable. The King of Wanga, in the valley of the Ganges, had a daughter who wedded a lion. She bore him twins —a son and a daughter. The son escaped from the den, bearing off his brother and sister, and the lion, enraged, began to lay waste the country. The king being dead, the government offered a reward for the destruction of the lion; and the son presented the head of the lion, his father, to the subjects of his grandfather. He was then elected king, and married his sister. His wife bore twins sixteen times, and the eldest of the family was Wijaya, the invader of Ceylon. Wijaya proved to be a very troublesome prince, and the people demanded his execution. He was, however, turned adrift with seven hundred followers, without oars or sails, and was carried by winds and currents to Ceylon. On his landing, he had adventures precisely similar to those which befel Ulysses when he met with Circe. The Circe of Wijaya was Kuweni, a magician and Yakko. The invader married, but afterwards deserted her. She then sought refuge in the city of Lanka-pura, which she had formerly betrayed to her faithless husband. She was put to death, and her children were saved from a similar fate by their uncle escaping with them to the country near Adam's Peak. Here, the elder having married his sister, according to the custom of his royal ancestors, they relapsed into the wild life of the mother's race. The progeny of these are supposed by Mr. Bailey to be the Veddahs of the present day. He thus accounts for their various characteristics and usages. The dread of their ancient persecutors would in early times generate a feeling of timidity and a wildness of character, which we know from the testimony of the "Theban traveller, was quite marked in his day;

for in relating the particulars of his visit to Ceylon, he makes use of the expression ἔφθασα ἐγγὺς τῶν καλουμένων Βισάδων, which really means that he stole a march upon them, as upon deer, or other wild creatures. Kuweni's children being informed of their lofty antecedents, would look down upon those who were not of princely stock, and their posterity would naturally retain the same feelings. This theory will also account for the acknowledgement on the part of the Singhalese of the high rank of the Veddahs—for the custom, which has so long prevailed amongst the latter, of males marrying the younger sister, and for the prevalence amongst them of the names of deities now worshipped in India, proving them to have preserved a remnant of Wijaya's faith. Their crude ideas and practices in the matter of religion seem to correspond to a certain extent with the precepts of Menu, and there are strongly marked traces in these of the Nât worship of India. Their particularity in the selection of food also argues that at some remote period they have been more fully under the influence of religious prejudices.

We have strong cause therefore, even making all due allowance for the fable mixed up with their history, to believe that the secluded condition of the Veddahs, their shyness and their timidity, were the result of hostility manifested by more powerful neighbours at an early period of their existence. It is very possible that the same cause may have produced similar phenomena and characteristics in the Andaman Islanders. Such is decidedly the opinion of Petermann with regard to the Bushmen. Their superior activity and difference of dialect, as well as the distribution of their numbers, lead him to suppose that they are not merely degraded members of the Hottentot race, but a distinct nation of that race, probably the first that penetrated from the north into that portion of Africa, and had subsequently been overpowered by invasions of the Hottentots proper. To strengthen this supposition it may be stated that there exists to the present time a violent animosity between the two peoples. The Yamparicos, a tribe of Diggers, residing west of the Rocky Mountains, habitually shun the Shoshonees and Utahs, dwelling not far from them. It is conjectured that the original stock of this miserable and secluded people were outcasts from these tribes. The Fuegians, another degraded and isolated tribe, do not seem to associate with their neighbours the Patagonians, and differ from them greatly in physical marks, save in color. Whether they

have had any feuds with them it is impossible to say. They appear to have been originally landed in their present habitat from a considerable distance. Pickering states that a great resemblance has been traced in them to the Chinooks, dwelling at the Straits of Fuca, on the western coast of North America. There is a further similarity in the shape of the paddles used by both tribes. According to Pickering the Fuegians are identical in physical characteristics with the northern aborigines. It is worthy of observation that, although the most of the known secluded tribes reside in barren and unproductive regions, that circumstance alone is scarcely sufficient to account for their physical and mental degradation. Ceylon, for example, is an exceedingly fertile country, abounding in edible productions, both animal and vegetable. It is quite a contrast to the regions in which the Shoshokee, the Andaman Islander and the Bushman have to struggle for existence. We find that peculiarities in the habits or disposition of these curious tribes have much to do with their degradation. The Bakalahari, the poorest of the Bechuana tribes, who reside in close proximity to the Bushmen, and under circumstances exactly similar, live in a very different style. The Bushman steals, hunts, attempts to satisfy his hunger with vermin, but will not tend cattle or cultivate the soil. The Bakalahari, wherever they can find a spot suitable amid their desert wastes, cultivate a few vegetables, and keep goats to assist in providing for their wants. The Bushmen, determined in their seclusion, will not mix with these although dwelling in their immediate neighbourhood.

Notwithstanding there may have been a difference originally in the mental qualities and powers of the various secluded tribes known to us, according to the races from which they have sprung, yet there can be no doubt that the causes which have stunted their physical growth have also arrested the due development of their intellects. Inadequate and irregular nutrition must cause a deficiency in the quantity and a deterioration in the quality of that vital fluid which, under favourable circumstances, keeps all the organs in a state of vigorous efficiency. And if, as we may reasonably suppose, either a failure in the quantity, or deficiency in the proportions of certain constituents of that fluid, compromise their functional efficiency, we may conclude that the brain must suffer as well as other portions of the body. In addition to such a cause of mental degradation we may enumerate the necessities, in a small and secluded community, for unions between those already related by consanguinity; as well

as the utter absence of any mental stimulant such as those which in civilized communities are called *aims*. Where the social condition admits of no ambitious aspirations, and where mental superiority would bring no commensurate advantages in its train, it is not likely that men will trouble themselves to exercise their minds about things foreign to the dull and daily routine of providing food and shelter.

The rarity of the reception of any ideas except those which have existed in a limited community for thousands of years, must unfit the mind for any fresh excursions into the regions of thought. Such a position as some of these secluded tribes occupy, would, even in the course of a few generations, reduce the minds of tolerably intelligent savages to a state of dull imbecility or mere animal and ferocious instinct: but when we take into consideration the hereditary transmission through centuries of degradation, of these inactive and incurious brains, their efficiency, according to the law of nature, gradually diminishing, the wonder is that the line between these outcasts and the beasts is yet so clearly marked, and that there still lingers amongst any of them an instinct of worship, and a vague notion of a spiritual existence.

Yet it is astonishing how, by contact with the superior races, minds of low development will become improved. The Australian was long supposed to have mental capabilities as poor as those of any other race; but facts, well authenticated, prove that the aboriginal Australian possesses a mind superior to what was formerly imagined of it. A quotation from a report transmitted to the English Government on the subject, states that his mind is quick and keen, and "rather like a treasure sealed up than a vacuum." The children learn a science like geography, which appeals to their external senses, very rapidly, though in more abstract studies, when mental processes are required, as in arithmetic, they are as yet deficient. It is said on good authority that they evince as much average capacity for improvement as English children. Probably in a few generations if the race be so long persistent, the reflective faculties may be brought into efficient action.

Such assurances as these ought to stimulate our philanthropy, and impress us with a high estimate of the character and vitality of the human intellect, which, as in this case, after so many ages of degradation, can by the exercise consequent on the communication of new ideas be gradually elevated to a higher and perhaps a normal standard.

REVIEWS.

Enumération des genres de plantes de la flore du Canada précédée des tableaux analytiques des familles, et destinée aux élèves qui suivent le cours de botanique descriptive donné a l'université Laval. Par l'abbé Ovide Brunet, professeur de Botanique.

We cordially welcome every attempt to encourage and assist the study of Botany in this country, and we therefore received with much interest the little work just issued by the learned professor at Laval University. It is probable, however, that its usefulness will not extend much beyond the students in Professor Brunet's classes, for whom it is immediately designed. To those not very familiar with scientific names a list of genera in the order in which they are to be treated of may prevent some embarrassment, and the analytical tables, though not the best we have seen, will greatly assist the beginner. Botanical classification is at present in a very unsettled state. The natural groups which it is the custom in this science to call orders, but which correspond with what in Zoology are termed families, are pretty well determined, though further study may lead both to subdivision and combination to a certain extent. There is also pretty general agreement respecting the highest divisions of the vegetable kingdom, which, though commonly called classes, bear more relation to the Zoological sub-kingdoms or branches; but the intermediate divisions which are obviously required, and which, if really natural, would at once enlarge the student's views and facilitate his labours, must be regarded as altogether unsettled. Amongst the MONOCOTYLEDONEÆ or ENDOGENÆ Lindley's *Dictyogenæ* may make a good class: *Glumiferæ* perhaps another, whilst the remainder must for the present be accounted a third which has been named *Floridæ*. Advancing to the DICOTYLEDONEÆ or EXOGENÆ, the highest vegetable sub-kingdom, the difficulty becomes much greater. The *Gymnospermæ*, indeed, which have but slender claims to be made a division of equal rank with the Monocotyledoneæ and Dicotyledoneæ, will clearly form one class in this great sub-kingdom, but beyond this we have as yet no great divisions of Exogens which are not merely artificial, and even so ill-defined as often to occasion great difficulty to the inexperienced student. Without referring to those which are less known in this country, and quite as liable to objection, we may mention the method of DeCandolle, its modification by Dr. Gray, and Dr. Lindley's

method. De Candolle's method with the Exogens is founded on the idea of proceeding from the most highly developed forms in which there is most multiplication and separation of the floral organs down to those in which from union or abortion the structure of the flower is apparently simplest. This is worked out by a quadruple division into sub-classes or great sections having the following names and characters:—1st. *Thalamifloræ*—petals distinct, stamens hypogynous, that is to say, the several circles of organs springing from the receptacle neither adhering together outwardly so that the stamens should seem to arise from the corolla or calyx, or adhering inwardly, the calyx or receptacle being attached to the ovary so as to place the fruit apparently below the flower. 2nd. *Calycifloræ*—with petals distinct or coherent, stamens perigynous or epigynous. 3rd. *Corollifloræ*—having a synpetalous corolla with hypogynous insertion bearing the stamens. 4th. *Monochlamydeæ*—having a single envelope or no proper floral envelope. That the series adopted by this great philosophical botanist is not perfectly satisfactory need be no objection, since no series can exhibit the real affinities of organised beings. That his divisions run into one another and are separated by very shadowy lines, leaving us in doubt on which side we ought to place particular forms, is hardly an objection since it is probable that no plan was ever devised to which it does not apply; but when we examine his arrangement in his own philosophical spirit, under the guidance of principles which we have learned from him, we cannot help seeing difficulties which it is, to say the least, very desirable to overcome. It may be acknowledged that the separation or mutual adherence of the circles of parts forming the flower, depending as it does on the closeness of their origin and the pressure to which they are exposed, is a valuable, and being easily observed, a convenient character, so that, though not giving us the natural classes which we earnestly seek, it deserves attention as a source of sectional divisions, but when we look to the application of the principle we find that whilst the hypogynose character distinguishes Thalamifloræ, Calycifloræ combines cases in which by outward adherence the petals and stamens seem to be inserted on the calyx, and those in which, the adherence being inward, the whole of the exterior circles invest the ovary, a structure entirely distinct in its nature, which is termed Epigynose, the other being Perigynose. It would almost seem as if, adherence of circles being at all admitted as of importance, the distinction of these two varieties necessarily followed.

Then in the Corolliflorae we have a synpetalous corolla to which the androecium entirely adheres, whilst the calyx exteriorly, and the gynoecium within, remain distinct. This is not unnaturally regarded as a special form of structure, yet if we make the adherence of the androecium outwardly without attachment to the ovary the main point, this will be, as Lindley makes it, only a variety of Perigynose structure. De Candolle's Monochlamydeæ is a very miscellaneous group, for the separation of which a new principle is introduced and one which forms very harsh and unnatural combinations. It is plain from his own words that this great botanist only considered his subdivision of Exogens as a temporary expedient to which he attached no importance, and in fact the prevalence of his method is to be attributed much more to its being the method of his invaluable Prodromus than to its own intrinsic merit.

Dr. Gray, whilst following pretty exactly De Candolle's series, neglects his sectional divisions, substituting a very simple triple division of Exogens into Polypetalous (much better called Apopetalous) in which division are included those plants in which, whilst all the exterior circles adhere over the ovary, the parts of the corolla above the inferior fruit are separate; Monopetalous (rather say synpetalous) where the petals cohere into a tubular corolla; and Apetalous in which the corolla is entirely absent. Under each of these divisions the orders are collected into groups intended to be more or less natural and thus imitating Lindley's alliances. This latter arrangement is a decided improvement, and the former may be considered as affording practical facility to the working botanist without the sacrifice of any principle. There are, indeed, numerous exceptions, but the student soon learns to be on his guard against them, and does not find them a source of serious difficulty.

The method of Dr. Lindley is explained and applied in his valuable work, "The Vegetable Kingdom." His division of Exogens, excluding from them the Gymnogens or Gymnosperms, is founded first on the completeness of the flower as to its reproductive system, or its diclinous character, which consists in the suppression in each flower of one of the reproductive circles of parts. The former group is subdivided according as the flower is hypogynous, perigynous, or epigynous in the insertion of its organs. Thus we have four sub-classes or great sections of Exogens as in De Candolle's method: but according to Dr. Lindley's view, the divisions are somewhat more natural and considerably easier

of application—and this view we are, from long experience of both methods, prepared to sustain, although we are far from thinking these sections really natural or likely to express the ideas of botanists after some years of further investigation and study. But Lindley's sub-classes have the great additional merit of being connected with his system of alliances, a set of more extended orders, which he has worked out with great labour and skill, and with such success that, notwithstanding the occurrence of what may appear to many botanists errors or serious difficulties, the advantage gained both in increased knowledge of the relations of plants, and in facility of examination, is too great to be neglected by any who have once appreciated it. Another great merit of Lindley's system is found in the nomenclature. He names all the orders from a genus assumed as a type by an adjective terminating in *aceæ*, leaving the other forms of Latin adjectives to express other degrees of affinity, and he names the alliances on the same principle by typical names terminating in *ales*, so that, instead of the confusion arising from miscellaneous terminations only chosen by the ear, or copied from the older authorities, we have a regular plan which is at once comprehended by the student and is an important aid both to his understanding and his memory. We cannot say that our taste is very indulgent to Dr. Lindley's English family names, but they are perhaps as good as any, and are really of little importance since a science cannot exist without scientific terms to express its teachings, which ought to take the form of a language common to the whole civilized world, and leading to no jealousies among the scientific labourers of various nations, and those to whom a Latin termination is a serious obstacle will never render much service to science, or derive much pleasure from it. On the whole, without attaching to it undue importance, and acknowledging that the natural grouping of plants between the sub-kingdoms (as we would call the three great well established divisions) and the so-called orders is as yet in its infancy, we recommend Lindley's method, given in a book which is indispensable to all botanists, as practically the best and the most desirable for application to local Floræ.

The Botanical collections of the University of Toronto, including above 8,000 species, are being arranged according to this plan, which is also taught in the classes of University College, and has thus become familiar to many zealous young botanists in Western Canada, and an important service would be rendered by any one who could

give a convenient summary of our local Flora, unembarrassed by the Southern forms which Dr. Gray has had occasion to include, and arranged according to Lindley's system, but with analytical tables adapted specially to our convenience.

Professor Brunet has the reputation of being an enthusiastic botanist, particularly well acquainted with the historical botany of Lower Canada, and zealous in promoting the science, so that with the aid of other earnest labourers that we know to be found in Quebec, the flora of that district ought to become well known. Considering what has been done at Montreal and Kingston, at Toronto, Hamilton, London, Belleville, and some other points, we must be steadily advancing towards a degree of knowledge of the vegetable productions of the country, which, with a little combination and intercommunication of observations would ensure a good national Flora.

W. H.

Synopsis of Canadian Ferns and Filicoid Plants. By George Lawson, Ph. D., LL.D., Professor of Chemistry and Natural History in Dalhousie College, Halifax, Nova Scotia.

(*From the Edinburgh New Philosophical Journal for January and April*, 1864).

We have been favoured by the author with a copy of this Synopsis, and we are anxious for several reasons to direct to it the attention of Canadian Naturalists. We need not say here that Dr. Lawson, whilst Professor at Queen's College, Kingston, made great exertions to promote Canadian botany, and that to him chiefly we owe the Botanical Society of Canada, which, though not perhaps very fortunate in its locality, and assuming too much in its origin, as if first promoting botanical pursuits in Canada, was in many respects well devised, and will, we hope, permanently promote and encourage a science which well deserves the attention of the more cultivated portion of our people. We wish it were extended to British North America, with the various portions of which our intercourse may soon be greatly facilitated, in which case Dr. Lawson, in his new sphere of action might continue to be amongst its most active members. All lovers of science in Canada regret that his connection with this Province was so soon broken, and heartily wish him success in his new field. The paper which we now notice is in some respects more adapted for

botanists and Fern-fanciers in Great Britain than for Canadians, yet the minuteness of its references to the localities of our Ferns is a feature which would have a special Canadian interest, only that, contrary to the general practice in such cases, localities are given as much for the commonest and most diffused species as for those of rarer occurrence, so that the botanist of a particular neighbourhood wonders to see ferns which he meets with in every walk, and believes to be diffused throughout the country, spoken of as if they were to be sought chiefly in a few specified spots. The list of Canadian Filiform plants is very satisfactory—a little, we agree with the author in thinking, in advance of the true number, yet with the doubts that unavoidably arise, as near to it as can be expected.

We may add a few notes relating to the species. Polypodium Vulgare seems to be well diffused but not common. It seems to be confined to rocks in this country, not growing on trees or even sheltered banks as in the British Islands. This circumstance sufficiently accounts for its comparative rarity. P. hexagonopterum is in our Toronto list, though by no means common. P. Phegopteris is exceedingly common and abundant in all parts of Canada which we have visited. P. Dryopteris is even still more abundant, contributing much by its great beauty to the adornment of our forest scenery. Like Dr. Lawson, we have thus far failed to obtain Canadian specimens of P. calcareum or Robertianum. We have visited no part of Western Canada where Adiantum pedatum is not abundant. Pteris aquilina is as common with us at Toronto as elsewhere throughout the Province. Struthiopteris germanica is very generally diffused in Canada, and occurs in great abundance. Onoclea sensibilis is in every moist grassy spot. The var. which gave rise to O. obtusilobata, Schkr, has been obligingly sent to us by Mrs. Traill from the Rice Lake district. We have a strong impression of having seen Canadian specimens of Asplenium ruta muraria, yet cannot at this moment remove the doubt which Dr. Lawson has been obliged to leave respecting its occurrence. Little as is the importance of priority in such a matter, we may as well state the fact that Scolopendrium vulgare was found at Owen Sound by Professor Hincks in 1857, being then laid before the Canadian Institute, and specimens placed in the University Museum, whilst Mr. Robert Bell, junr., to whom Dr. Lawson ascribes the discovery, found it in 1861.

The species of Lastraea of the dilatata group are very uncertain, and we have great doubts respecting our Canadian forms. We have

not seen filix mas from Canada. We have found cristata in swamps in several places, as at Woodstock, County of Oxford, C.W. Goldieana has been found near Toronto. Marginalis, and in moist places Thelypteris, are every where common. Noveboracensis is not very uncommon, and we think it is a distinct species.

Polystichum angulare is not common. Lonchitis is abundant at Owen Sound, where Professor Hincks gathered it in 1857, not 1859, as stated by Dr. Lawson. Acrostichoides is found in moist woods, and is one of our commonest ferns. We have lately seen a very remarkable fern, exactly resembling a barren frond of Polystichum Acrostichoides (to which species we have no doubt that it belongs,) but in full fruit, without the contracted fertile portion, the sori being on all the leaflets, not very close, and with the indusium approaching the Lastraea form. We take this to be a mere anomalous individual, but it gives an instructive lesson on the variability of some of our best characters. We have found Cystopteris fragilis at Whitby, C.W., and we have Canadian specimens of var. angustata, a very distinct form, though we believe rightly regarded only as a variety. Cystopteris bulbifera is one of our handsomest ferns, and very common in moist spots in woods. We gathered Woodsia ilvensis on Belœil Mountain as long ago as 1848. The Osmundas are all common. Botrichium Virginicum is very common in the Toronto district. Lunarioides is also found. We have not distinguished B. obliquum, nor have we any evidence of the occurrence of B. Lunaria in Canada.* In the Lycopodium family we have found all the species indicated by Dr. Lawson. We have the Isoetes from the North of Lake Simcoe. Equisetum fluviatile, Linn, for which Dr. Lawson adopts Ehrhart's name Telmateia, and Dr. Gray prefers Schreber's name eburneum, is by no means common, though an undoubted Canadian plant. We can affirm positively that the European Equisetum palustre is a native of Canada, having found it five or six years ago in a ditch near the river Don a few miles north of Toronto, and being well acquainted with the plant from our English experience.† Equisetum sylvaticum grows finely and abundantly on the

* Whilst passing this paper through the press, we have seen a fine Canadian specimen of B. Lunaria, which settles the question.

† Since this was written we have received a letter from a very zealous and acute botanist, Mr. Macoun of Belleville, stating that amongst plants sent by him to Sir W. J. Hooker, Equisetum palustre was found; it is therefore certain that this plant grows as far south as the northern shore of Lake Ontario, and it becomes very probable that Pursh had seen it in the Northern United States.

Humber plains near Toronto and is probably not uncommon in Canada. Equisetum arvense is but too common everywhere. Equisetum limosum is common in watery places. Equisetum pratense, Ehrh., for which Dr. Lawson adopts Wildenow's name umbrosum, is very common near Toronto. Equ. hyemale is exceedingly abundant in Western Canada generally, and Equ. robustum grows near Toronto, where it was first observed by Dr. Lawson. Equ. variegatum is we believe rare. Equ. scirpoides occurs almost universally in damp woods. In Dr. Lawson's paper descriptions and synonyms are given, and the chief varieties of each species are carefully noted, so that it is a summary of the information at present possessed on the subject.

W. H.

THE METEOR OF 14TH MAY, 1864.

AEROLITES AND SHOOTING STARS.—BY M. J. JAMIN.

(*Translated from the* "*Revue des deux mondes,*" 15*th July*, 1864.)

On the 14th of May last, M. Brongiart, of the *Académie des Sciences*, being in the country near Gisors, saw at eight o'clock in the evening a very brilliant meteor. It was seen towards the south, passed from West to East, and did not attain an elevation greater than from fifteen to twenty degrees above the horizon below which it shortly vanished. Such meteors are common enough, but this particular one is remarkably interesting, for, on the morrow, all the newspapers of the South West of France informed us that it had been seen at the same hour from Paris to the Pyrenees, and a great number of letters were addressed to the Academy describing all the circumstances of the phenomenon. There could be no doubt that it was a grand scientific event, and the investigation it demanded has been made with conscientious care, by M. Daubreé, who was naturally marked out for this pursuit by the nature of his previous studies, and authorized to undertake it by his double capacity of member of the Institute—and Professor at the Museum. Thanks to the documents he has published and the researches he instigated, we now know all that observation can tell us of this memorable occurrence.

Since the meteor was seen in the South by the cities of Gisors and Paris, it was in that direction that the enquiries into the particulars of its appearance proceeded. On interrogating the inhabitants of the zone which comprises Laval, Le Mans, Blois, Tours and Bourges, it was learnt that these cities on the same date and hour had been all at once flooded with a vivid light, and that numerous persons, attracted to a promenade by a beautiful spring evening, had at once, as in Paris, followed with their eyes a ball of fire half as large as the moon. It left behind it a luminous train which gradually melted into a white trace like a cloud elongated. At all these stations the ball was seen still in the South, and it was therefore to be sought for further down. If we notice in passing, so as not to

neglect any intermediate station, the accounts from Napoleon Vendée, Poitiers, Saint-Amans, ... it becomes evident that we are approaching the phenomenon, because on the one hand the size of the meteor increases, and on the other it becomes more elevated in the heavens; the explanation of which is found in the sphericity of the earth, being the same facts that are observed on gradually approaching a mountain or a distant coast. Continuing then our progress southwards, we come to the line passing through Saintes Angoulême and Tulle, and here we learn a new and characteristic circumstance. The ball, appearing still more elevated above the horizon, suddenly burst, throwing out sparks in all directions, and this explosion, as in a rocket, ended its appearance: and in order that no particular of this resemblance should be wanting, there remained above the spot where the final disruption took place, a cloud-like appearance, white, immovable, rounded. and lasting for a long time. We come at last to the very seat of the phenomenon, on a line nearly straight, which starts from Nérac and goes towards the villages of Nohic and d'Orgueil, passing a little to the South of Agen and Montauban. Along the zenith of this line the meteor passed. The inhabitants saw it over-head, larger than the moon. It appeared to have movements of oscillation or rotation, and threw behind it very vivid sparks and a sort of jet of white vapors comparable to the smoke which escapes whistling from an overheated stick of wood on the hearth. When the final explosion took place, an immense and splendid sheaf of fire threw fragments in all directions, a cloud formed, and then everything disappeared, according, at least, to most of the witnesses, but two of them affirm that they saw the meteor, stripped of its brightness, proceed as a dark red ball and become extinguished in the distance. After an interval of time, which varied according to the position of the observers, but which, noted carefully by each of them, extended from twenty-four seconds to five minutes, there was heard a dull but very intense sound, compared to a discharge of artillery or the roll of thunder. It was not a single detonation like that which follows the explosion of a rocket, but a long continued noise, as if it had been generated at the successive points of the meteor's path, and had reached the ear after different intervals by reason of the unequal distances it had to traverse. This circumstance is deserving of remark. The disruption of the meteor had scarcely ended, and the following report ceased to resound, when the final phenomenon, as might have easily been foreseen, occurred in an abundant downpour of meteoric stones. They were seen to fall beneath the point where the explosion took place in a narrow tract comprised between the villages of Mont-Bequi, Campsas Nohic, and Orgueil. They descended obliquely from West to East, the natural consequence of the combination of their initial velocity and gravity, and they were hot on reaching the ground: a peasant burnt himself by attempting to pick up one which had fallen in his granary, and it was remarked that the grass where they fell was turned yellow by the contact. The surface of these stones was covered with a black coating like varnish (as may be noticed on bricks too much baked), and this proves that they had undergone a superficial fusion, which indeed can be reproduced on them by cutting and exposing the surface to the flame of a blow-pipe; and since it is necessary, in order to effect this, to raise them to a red-white heat, it must follow that they had reached this temperature at least before the fall.

As these stones come from the heavens, our first curiosity naturally is to know their chemical composition, and it is almost with disappointment that we learn that they differ in no respect from earthly substances. The meteorite of Orgueil has been analysed by M. Cloez: it is black, soft, of an almost pasty consistence marks like a chalk, contains magnetic sulphuret of iron in little crystals which sparkle through its mass, and has about five per cent. of charcoal which gives it its color. The presence of carbon in aerolites had been previously established, but it is of so rare occurrence that only three examples could be cited previously to this. The carbon, however, is not in a free condition, but is combined with hydrogen and oxygen, and (which is very singular) forms a combination almost identical—so to speak—with the turf which is formed in bogs by the decomposition of aquatic plants. As to the origin in such a situation of this curious substance, it is clear that it is and possibly may always remain unknown. Lastly, M. Cloez found in this new meteorite a large quantity of soluble salts which served as a cement to bind the mass together and preserve its coherence, so that on being immersed in water it becomes disintegrated, and falls to the bottom of the vessel. The rains, therefore, will have caused such fragments as were not picked up to crumble on the ground, and our globe will thus have gained, without keeping the least trace of it, these masses borrowed possibly from other worlds.

All these details, rather picturesque than scientific, are enough to give a general idea of the phenomenon, but they teach us absolutely nothing touching its nature, origin, or course. A number of questions present themselves to the mind, and to answer them, it is seen to be, above all, necessary to trace in the heavens the path taken by the meteor, or, as philosophers call it, its *trajectory*. M. Daubreè has entrusted this part of the work to Commander Laussedat, Professor in the Polytechnic School, whose speciality in matters of this sort has been legitimately gained, and he has applied himself to the task assiduously.

In order to render intelligible the possibility of such an investigation, let us take a simple example. Imagine a telegraphic wire stretched parallel to the course of the Seine at a certain height above the houses on the banks. An observer who places himself at night on the right bank would see it projected in the neighbourhood of certain stars in the South, while another on the opposite side would see the black line of the wire towards the north across different stars. It is certain that the visual lines which, starting from the eyes of each observer, pass to the observed stars on each side, cross each other above the Seine upon the wire itself; and that, if we could lay down or calculate the positions of the stars, we could easily lay down or calculate the line of intersection of their visual lines, that is the wire itself. Returning home, the two observers can communicate their observations, and measure on a celestial sphere the direction and height of the stars in question, as seen from the places of the observers at the time of observation. They will thus obtain the direction and inclination of the visual lines. This done, they will mark on a map of Paris the stations they severally occupied, and will thence draw lines in the direction of the visual lines, and these will intersect in points situated on the trace of the wire at heights which it is easy to calculate, and thus the position of our imagined telegraph wire will be exactly determined.

It is evident that we can make the same observations on the luminous track marked out in the heavens by the passage of a meteor as on the wire above spoken of, and can thus trace on a chart the series of points it has passed through, as well as the height of those points above the ground. Now it turns out very fortunately that three experienced observers, MM. Lajons at Riemes, Lespiault at Nérac, and Pauliet at Montauban, had noted very precisely the stars through which the meteor passed, and the exact points where it had appeared and exploded. Thanks to their observations, M. Laussedat has succeeded in reconstructing the trajectory of this meteor. An accidental but valuable circumstance furnishes the first confirmation of his work. One of his correspondents at Ichoux near Landes saw the ball fall vertically, like a stone falling freely under the action of gravity. This illusion proceeded from the fact of the trajectory being exactly in a vertical plane passing through the observer's eye; and, accordingly, it was found that the curve traced on the chart by M. Laussedat did pass through the village of Ichoux. Another more delicate and complete example of verification is the following: the trace on the chart assigns for the place of explosion a point situated above Nohic at a height of from fifteen to twenty kilometres; at this point, therefore, the sound produced must have been the most intense, and must have thence radiated to the surrounding stations through distances which can be easily calculated. As sound travels at the rate of three hundred and forty mètres a second, it was equally very easy to calculate the time at which it ought to arrive, or the interval elapsing between the sight of the explosion and the perception of its sound. On the other side, nearly all the observers, notwithstanding their surprise, had approximately estimated the length of this interval, and their estimation can be compared with the results previously given by the calculation. The agreement of these numbers having been very nearly complete, we cannot retain any further doubt as to the exactness of the results which it remains for us to make known.

The meteor came certainly from spaces inaccessible to our senses, but when its glow was first seen, it was at a height of fifty kilometres above the ground. We may pause on this first fact. We do not know the exact height where the stratum of air which envelopes us terminates, but it is ascertained by experiment as well as by reasoning that the atmosphere grows rarer as we ascend, and that at a height of 50 kilometres the pressure is reduced to one-thousandth of what it is at the sea-level. The meteor had then already entered our atmosphere when it was first perceived, and afterwards continued its course, approaching the ground till within 16 or 20 kilometres, or about four or five leagues, nearly four times the height of Mont Blanc. At this point it was over Nohic and exploded. Now the air is the vehicle of sound; in proportion as we rise from the ground and the air becomes rarified, sounds lose their intensity. In the celebrated voyage which Gay-Lussac and Biot made in a balloon, they were astonished at the weakness of their voices, and found that at a height of eight kilometres the report of a pistol was like the crack of a whip. No one has ever risen to a height of 20 kilometres, still we know that the pressure there is reduced to one-tenth, and that all sounds must be weakened in a proportion much more considerable than in the instance just cited. Now, since the explosion of our meteor rendered it audible at a dis-

tance of 20 leagues, it follows that it must have been generated of a magnitude and intensity which afford us the first appreciation of the grandeur of the phenomenon. This appreciation is confirmed in another way. Most of the observers have compared the size of the meteor to that of the moon, and though possibly there is some exaggeration in this assertion, yet making all allowance for this, we may ask what would be the real size of this ball of fire in order that it might have at the distance in question the apparent diameter of the moon. It is easily found that the diameter must be between four and five hundred metres. According to this calculation, it was from four to five times larger than the Cathedral of Paris, and we cannot help a sort of retrospective apprehension while thinking of the inhabitants of Montauban:

> Nous l'avons cette nuit, Madame, échappé belle,
> Un monde près de nous a passé tout du long. . . .

To these weighty results the calculations of M. Laussedat add a more serious subject of astonishment. As the precise places and times of the appearance and extinction of the meteor were noted, it has been possible to calculate the space it passed through in a second of time, and this is found to have been 20,000 metres or five leagues. Let any one represent to himself a distance of five leagues between two places with which he is familiar, say from Paris to Versailles, and then let him fancy himself carried over all this distance during a single pulsation, he will then appreciate the velocity of our meteor and will recognise it as altogether out of proportion to such as we are capable of producing or observing on our earth. If we wish to find velocities at all comparable, it is not on the earth but in the heavens that we must seek them. There indeed all the stars move with inconceivable velocity, the terrestrial globe itself, making the circuit of the sun in a sidereal year, is whirled at the rate of 30 kilometres per second, and with a velocity comparable to this did the meteor of Orgueil travel. From this indication alone we might infer that it came to us from the planetary spaces, and that in fact it is a real star of which we are endeavoring to trace the history; but, as what we are about to say is the result of antecedent investigations, common to all the asteroids of this kind, it will be convenient to drop the particular example we have chosen and to generalise and thus elevate the subject.

In many places we meet with malleable masses, composed almost entirely of iron, the nature of which is in strong contrast with that of all the neighbouring rocks but is identical among themselves. Everywhere that we meet with them, some tradition preserved amongst the inhabitants tells us that they have fallen from the sky. A very celebrated one, of which a fragment is in the museum at Paris, was found by Pallas in Siberia. The greatest known is that which is to be seen at the source of the Yellow River; this is 15 metres in height, and the Mongols, who call it the North Rock (*le Rockêr du Nord*), relate that it fell in the track of a fiery meteor. The most numerous have been found in Chili, in the desert of Atacama, where they form two distinct collections in very confined spaces, lying on the ground half-buried as at the moment when they fell, and so abundant that they were formerly carried to the port of Cobija and used to shod the mules. Besides iron, these masses contain nickel; they are so malleable as

to be easily forged, and there is no doubt the inhabitants of the old world used them in their employments as easily as gold, and thus may be explained at once their scarcity in our countries, and their abundance in the American deserts. Dr. Wollaston demonstrated quite recently this conjecture by analysing the knives used by the Esquimaux of Baffin's Bay, and as they contained nickel, he justly inferred that they were produced from the iron fallen from the sky. It is in fact probable that such is the common origin of these divers masses; still there was only known one authentic fall, namely in 1751 at Hradschina near Agram. But putting aside uncertain traditions, we find in history numerous accounts of events like this of Orgueil. The oldest of the known aerolites fell in Crete 1478, B.C. The priests of Cybele preserved it in their temple as a personification of this goddess, and in old days every fresh fall was naturally attributed to the gods. The Chinese annals, very fully kept in this respect, abound in accounts of meteors of which the description would apply without change to this of Orgueil. An author, named Ma-tonau-li has given a circumstantial catalogue by which we see that the Chinese entered on this question long before our era. Chladni undertook the same enterprise for Europe, and collected the localities and dates of more than 200 falls. No time or country has been free from such occurrences, always observed with curiosity, related with eagerness, and frequently made use of by credulity.

The learned societies, to their honor be it said, required positive proofs before admitting as realities these showers of meteoric stones. The Academy of Sciences was so little in favor of this belief that it declared in 1769 that a stone, picked up at the moment of its descent by many persons who had followed it with their eyes to the instant when it reached the ground, *had not fallen from the sky.* The opposition of public opinion lasted till 1802, but at that period, an abundant shower of stones having been observed at Laigle, the Academy seized the opportunity thus offered to it of enlightening itself on this subject, and commissioned Biot, then the youngest of its members, to open a severe inquiry. There could not have been a better choice for so delicate a mission, nor one more capable of enforcing its convictions. He found the stones to be all identical with one another, some of them having been picked up by himself ; he made an elegant report of his mission, and the cause was decided. The most able chemists, among whom may be cited Langier, Thénard and G. Rose, analysed the aerolites, and found them to possess a character in common. Systems were imagined; some thought that the aerolites were projected from volcanoes of the moon, now extinct; others invoked the intervention of electricity which is the *deus ex machinâ* for all unsolved questions; while others said they were fragments of planets and comets destroyed by mutual collision. Finally they ended where they ought to have begun, and took observations. The number of persons devoted to this troublesome task is now very considerable. We may cite among the most distinguished, M. Haidinger, member of the Academy of Vienna; Father Secchi, Director of the observatory of the Roman College, and Prof. Heis of Munster, who brings to these questions as much perseverance as talent. In England, a commission of philosophers undertook the duty of collecting and instigating observations; it reckons among its members MM. Glaisher, Brayley,

Prestwich, Alex. Herschel and Baden Powell. Every year it publishes a programme of the investigations it thinks most useful to make, and a summary with notes of those which have been executed. In this list, already long, we must still include M. Schmidt at Athens, M. Poey at Havana, and lastly a gentleman who has gained in France on this occasion a kind of celebrity, M. Coulvier Gravier.

It might have been predicted, from such a number of philosophers devoting themselves to this study, that the history of meteorites would gradually be settled, and so in fact it has turned out. We proceed to relate its principal features. Meteors, when their size is considerable, present the same characteristics as distinguished that of May 14th; the same brilliancy, the same train of sparks followed by a persistent cloudiness, often an explosion, and lastly, though less frequently, a fall of aerolites. They are observed of all magnitudes, but, the smaller they are, the shorter is the extent of their path, the more rarely does an explosion take place, and the train grows weaker. Finally, but without specific lines of demarcation and by insensible degrees, we come to mere shooting stars. The nature, origin, and laws of these latter should therefore be carefully studied, and the conclusions drawn will apply to those which by way of exception are large enough to constitute meteors.

We may possibly be astonished to learn that these shooting stars, which on the first aspect present an image of the most desperate irregularity, nevertheless, on the whole, obey well demonstrated laws of periodicity. These laws have been discovered by observations continued during a great number of consecutive nights, and by taking at the end of each year the mean number of shooting stars that have been observed in each successive hour from evening to morning; this is called the *horary number*, and, omitting certain exceptional nights of which we will speak presently, it is found that this number increases progressively from 6 P.M. to 3 A.M., then diminishes till day break, and probably throughout the day till the next evening. In fact the number is 6 between 6 and 7 P.M., 10 between midmight and 1 A.M., 17 between 2 and 3 A.M., and falls to nearly 13 between 6 and 7 A.M. In taking these observations, it was speedily noticed that all these nights did not give identical results, and that those of the 10th, 11th, and 12th August are so rich in shooting stars as to count as many as 110 in an hour. This superabundance at this epoch has been established since the commencement of the century by a very great number of observers, and it is still more remarkable that it appears to have existed from all antiquity. The proof of this is found in the Chinese annals of which I have spoken, and which were examined by E. Biot. These note particularly in the years 830, 833, and 835, a large maximum which fell towards the end of July, reckoning this date by the Gregorian calendar. It is known, however, that the axis of the earth does not retain an invariable direction in space but describes, like the axis of a top, a cone the circuit of which it completes in 23,868 years. It results from this that the time of the equinoxes is continually changing, and that at the same dates from year to year the earth occupies in its orbit progressively differing positions. Now, taking this circumstance into account, it is found that at the epoch when the Chinese observed the maxima of the years 830, 833, and 835, the earth occupied in its orbit the position it now has on Aug. 10th, where the maximum is now reproduced. The regularity

of this phenomenon is thus demonstrated by a long period of observations. Regarding it more closely and examining each year, it is found that this maximum number is subject to deviations both of excess and defect. In 1800, on Aug. 10th, there were only counted 59 stars per hour; in 1848, there were 110; ten years after, in 1858, the horary number fell to 88, and since that year it has been gradually recovering. There is possibly a law of periodicity in these oscillatory movements, as there was in the maximum recorded by Olbers and observed by him on Nov. 12th, 1799; it was extremely rich at its commencement, but gradually diminished almost to zero, afterwards as gradually increasing till it regained its original brilliancy in 1833, when 130 per hour were counted; after this year, it again decreased and has disappeared; but, as the interval between the first two appearances was 34 years, a third is expected in 1867. Seeing that these excessive showers occur always at the same epoch, it must necessarily be admitted that the earth in its annual course meets at the same points of its path with banks of corpuscles disseminated through planetary space, and in this view there has been proposed a hypothesis as ingenious as seductive. It is suggested that these asteroids are scattered on the circular contour of an immense ring, having the sun in its centre, along which they travel, one after the other, each individually completing like a small planet a regular circuit round the sun. This great bank would be crossed by the earth on August 10, and we should perceive traversing our atmosphere all those corpuscles which passed in our neighbourhood. One circumstance, not yet well determined, but generally suspected by all observers, tends to augment the probability of this hypothesis—it has been remarked that on Aug. 10, the greater part of the shooting stars seem to proceed from one and the same point in the heavens. The real situation of this point is not agreed upon; some place it in Cepheus, and others in Cassiopeia or Aries; but wherever it may be, this common track which all the shooting stars of Aug. 10 follow, would be the path of the corpuscles in the ring which includes them, during their revolution round the sun. It is not my wish to write a romance, and yet I cannot pass over in silence some results which Prof. Twinning has announced, and the responsibility for which I leave to him. According to this author, the grand ring of corpuscles has a diameter nearly equal to that of the earth's orbit, to the plane of which it is inclined at an angle of 96 degrees; its breadth is from 2,000,000 to 5,000,000 leagues, and it consists of 300,000 milliards of corpuscles, which revolve about the sun in 281 days. Supposing each of these to have a radius of one metre, and that they were all united to form a single sphere, the volume of this would be scarcely one tenth of the earth's. I repeat that I do not believe we are yet in a position to state numbers so precise, but we may certainly predict thus far—that a continuation of the observations will be sufficient to establish a theory in which reality will replace imagination. But in order to arrive at this, it will be necessary in the first place to calculate the trajectories of these wandering bodies. This work has long ago been commenced in the case of the meteors, as these have a long course, and are visible to a great number of persons, and thus there are always notices enough of this appearance to calculate the conditions of their passage. This is what has been done for the meteorite of Orgueil, and which had already been

done, and possibly with more precision, for other similar meteors. M. Petit, director of the Toulouse Observatory, proved long ago that these fiery globes describe hyperbolas, a kind of trajectory which goes off to infinity. Last year on March 4, a meteor which appeared over the north sea, and was observed at different places in England and Belgium, was calculated by M. Heis; it also had a hyperbolic trajectory, and its initial and terminal heights were 174 and 28 kilometres with a velocity of 63. Prof. Newton has also executed some similar determinations, and quite recently M. Alex. Herschel communicated to the Royal Society a list of eleven whose orbits were determined. By all these well ascertained cases, we have acquired the certainty that these apparitions are caused by actual asteroids coming from planetary spaces which enter our atmosphere where they describe hyperbolas, and move with velocities comparable to those of the planets themselves.

The question presented more difficulties in the case of mere shooting stars, but a new instrument came to the help of astronomers—the electric telegraph. M. Heis was the first to make use of it in 1851 between Munster and Herbersthal, Two observers established at these stations examined simultaneously the same part of the heavens; when a shooting star appeared, they announced it by telegraph, and the signals coincided if it was the same star they both saw. Then they noted carefully its apparent path among the constellations, and this was sufficient to enable them afterwards to calculate its trajectory by the method already explained for the meteor of Montauban. Ten years afterwards Father Secchi between Rome and Civita-Vecchia recommenced the same investigation by the same method, which he believed original. A great number of illustrious persons assisted at these investigations, which resulted in proving for the second time, as they had for the first, that the shooting stars are actual meteors, only of inferior dimension, projected in space at a rate of many kilometres per second, and reaching our atmosphere to become inflamed.

It was necessary to enter on these various explanations before considering how the cosmical corpuscles become heated to such a degree as to melt and be dissipated. The theory I proceed to describe is the result of successive labors in which many philosophers were concerned. In 1848, Sir J. Herschel in the *Edinburgh Review* traced the first outlines of it; then M. Haidinjer, in 1861, developed its principle consequences before the Academy of Sciences, but it is only in 1863 that M. Reinholds Reichenbach has submitted to rigorous calculation the principles adopted by his predecessors. These investigations allow us to construct theoretically the history of these shooting bodies; let us see how far it is conformable to the observed facts.

As soon as a meteoric globe with its enormous velocity enters the atmosphere it encounters a resistance which slackens its progress, this resistance being very great on account of its rapidity; it can be easily calculated, and, according to M. Reichenbach, it would be sufficient to destroy almost completely in ten seconds the velocity of a bullet which had been projected at a rate of 100 kilometres per second. Suppose that the meteor had lost only one hundredth part of its velocity through this cause, there would have been generated a quantity of heat which can be exactly calculated, and which would have been employed in heating the

globe and the air surrounding it. We learn from M. Reichenbach that it would be effective in raising the temperature by 75,000 degrees, supposing that no heat was lost by radiation, or by only 5,000 degrees if it is admitted that it escapes immediately after its production. The real elevation of temperature is therefore included between 5,000 and 75,000 degrees, considerably exceeding anything that we can produce artificially. Under these conditions, the globe melts, and the surface becomes covered with this vitreous glaze which is characteristic of the fallen stones. Not only does it melt, but at a temperature of 5,000, iron and carbon burn, throwing out brilliant sparks in all directions, and all known substances are reduced to incandescent vapors. The meteorite will then be seen in flames, and will be followed by a fiery train which will give it the appearance of a rocket. This train will then be extinguished, but the substances, which have produced it, remaining suspended in the atmosphere, will then leave a persistent cloud. If the stone be of small dimensions, as is generally the case, it will be entirely burnt up ; we see a star shoot, reduce itself to smoke, and all is over ; when it is of larger size, it lasts longer, and has a longer path in which we can follow it ; it drives before it the layers of air in its way, and these are compressed, heated, and become inflamed. By a contrary reason, it makes a vacuum behind into which the anterior air rushes round the contour of the ball, und the meteorite is thus wholly enveloped in an atmosphere of gas and inflamed vapors. We may pause at this result, as it is of a nature to relieve our apprehensions. In these meteors it is not the solid part, but the surrounding atmosphere, which we see in flames ; it is this latter which attains such large dimensions, while the nucleus which is hidden from us is incomparably smaller. This atmosphere has certainly a very menacing appearance, but it becomes dissipated as soon as the velocity diminishes, and this is why history has had no catastrophe to record, why the fragments are almost always very minute, and why such formidable appearances end in such small realities.

While the meteor compresses the air, this latter by the reaction of resistance presses its anterior face, and if we wish to have an approximate estimation of this force, let us consider what happens during storms. When these reach their most terrible intensity, they have a velocity of 40 metres per second, and exert a pressure equal to 38 lbs. on every square foot of surface exposed to them. This pressure will remain the same, if, by a mere change of relative conditions, we projected with that velocity a meteorite of one square foot anterior surface in the atmosphere at rest ; but, if instead of 40 the velocity were 40,000, the pressure increases in an enormous proportion, and M. Reichenbach tells us that it reaches 700 atmospheres at a height of 18 kilometres above the ground. There is nothing but iron which could resist such a pressure without being destroyed. Now these conditions being very similar to those of the Orgueil meteor, it must be admitted that it underwent a similar pressure, and that was the reason why it split suddenly into splinters as a stone does when thrown against a wall. At the moment when this disruption was effected, the whole phantasmagoria of its surrounding atmosphere vanished, and we could at last put a finger, not without astonishment, on the ridiculous cause of so mighty a fuss—some fifty stones

weighing in all 20 pounds! Yet, small as they may be, they bring us lessons of a varied and precious kind. Coming to us from the heavens, they bring us the matter which revolves among the stars, and of which probably these are composed; they tell us that, even in the most remote spaces, the material world is built of the identical materials that we find on our earth; the method by which M. Kircher has been able to analyse the sun has been much, and very justly admired, but it is only just to call attention to the fact that in the meteorites we find the metals which compose that luminary, and that besides we there meet with carbon, chlorine and ammonia, which escape the analysis of the spectrum.

If, by a concurrence of circumstances unhappily but little probable, one of these stones were to fall at the feet of a philosopher prepared to examine it on the spot, it would reveal to him another mystery. It is known that the temperature diminishes as we rise above the ground, and that it must be very low in the celestial spaces, but we are altogether ignorant of the degree of depression; this we might learn from the aerolites. Some of these being almost entirely composed of iron, are good conductors of heat, and the enormous heat which melts their surface may be propagated into the interior of this mass so that they reach the ground as red-hot balls, from which no conclusion can be drawn. But this is not the case with such aerolites as are of an earthy composition; these transmit the heat through their mass only slowly; their exterior surface alone may be heated during the short interval of their passage through the air, and the cold which they retain in the centre would return to the surface after the fall. It was in fact observed that the stones which recently fell in the Punjaub froze the hands of the persons who lifted them. Now it is this temperature of the centre of large meteoric masses which it would be so desirable to measure, for it is that of the celestial spaces from whence they set out to reach our earth.

My object has been to describe results which are acknowledged by science in earnest; may I be permitted to indicate in one word some fantastic notions which are cherished by the vulgar but repudiated by scientific men? Some persons have done shooting stars the honor to affirm that they preside over the changes of weather, or at least that they enable such to be foreseen; they are driven to appeal to these as a last resort after having vainly invoked all the constellations of the sky, the planets, the moon and the comets. The Academy, on being consulted, answered that such an influence was not proven—a polite reply! On the other side, MM. Heis and Secchi, the acknowledged astronomers, whose competency is undeniable, declare that such indication,—given by those celestial corpuscles, is absolutely false. The public will do well to be on their guard against these inexact predictions which are as often contradicted as confirmed by the event. With this reservation, everybody may encourage M. Coulvier Gravier to persevere in the study he has begun of shooting stars, and even to publish his observations, for it may well happen that a scientific discussion will draw from them grave results, which they probably involve but which he has not been able to find in them.

J. B. C.

CANADIAN INSTITUTE.

SIXTH ORDINARY MEETING.

30th January, 1864.

The President, The Rev. J. McCaul, LL.D., in the Chair.

I. *The undernamed Gentleman was elected a Member:*

H. W. Lauder, Esq., Barrister, Toronto.

II. Some remarks were made by Rev. H. Scadding, D.D., on Greek and Roman coins in the collection of the Institute.

SEVENTH ORDINARY MEETING.

6th February, 1864.

The President, The Rev. J. McCaul, LL.D., in the Chair.

I. *The following donation for the Library was announced.*

" Report on the construction of a military road from Fort Walla-Walla to Fort Benton, by Captain John Mullen, U. S. A., per Hon. J. M. Broadhead, Washington. 1 Vol.

II. *The following Paper was then read:*

1. By D. Tucker, Esq., M.D.:

" On certain modern views concerning the ordinal arrangement of the higher mammalia."

EIGHTH ORDINARY MEETING.

13th February, 1864.

The President, The Rev. J. McCaul, LL.D., in the Chair.

I. *The following Paper was read:*

1. By Prof. E. J. Chapman, Ph. D.:

" On the comparative anatomy and geological relations of the archæopteryx."

NINTH ORDINARY MEETING.

20th February, 1854.

The President, The Rev. J McCaul, LL.D., in the Chair.

I. *The following donations for the Library were announced.*

From the Royal Geographical Society of London.

The Journal of	Vol. 31,			1861.	1
The Proceedings of	Vol. 6,	No. 3,		1862.	1
"	"	"	4,	"	2
"	"	"	5,	"	1
"	Vol. 7,	"	1,	"	1
"	"	"	2,	"	1
"	"	"	3,	"	1
"	"	"	4,	"	1
"	"	"	5,	"	1
Not bound, total					10

FROM THE GEOLOGICAL SOCIETY OF LONDON.

The Quarterly Journal of........	Vol. 18,	Nov. 1,	1862.	No. 72,	Part	4
	Vol. 19,	Feb. 1,	1863.	" 73,	"	1
	"	May 1,	"	" 74,	"	2
	"	Aug. 1,	"	" 75,	"	3
	"	Nov. 1,	"	" 76	"	4
List of the Geological Society of London		Nov. 1,	"			1
Charter and Bye Laws................			1862.			1
Not bound, total..........						7

FROM THE ROYAL ASIATIC SOCIETY.

The Journal of........................	Vol. 20,	Part 1,	1862	1
	"	"	1863	1
Not bound, total				2

II. Professor Chapman laid on the table a specimen of allanite, a mineral newly found in Canada, and also a short communication upon it.

Doctor McCaul in the absence of Doctor Wilson's paper, made some remarks upon the Roman army of occupation in Britain.

TENTH ORDINARY MEETING.

27th February, 1864.

Vice-President, S. FLEMING, ESQ., C.E., in the Chair.

I. The Vice-President announced the Resignation of Mr. Wilson as Recording Secretary from ill health, and stated that the council had appointed in his place Mr. W. Mortimer Clark and hoped he would accept the office.

II. *The following donations for the Library were announced.*

FROM THE ROYAL SOCIETY OF EDINBURGH.

Transactions of..............	Vol. 23, Part 2,	Session 1862–63.	1
Proceedings of..............		Session 1862–63.	1
Not bound, total.........			2

FROM T. C. WALLBRIDGE, M.P.P.

Le Rougisme en Canada, Pamphlet.................................. 1

FROM NATURAL HISTORY SOCIETY, DUBLIN.

Proceedings of........................	Vol. 3,	Part 1,	1859–60	1
"	"	" 2,	1860–62	1
"	" 4,	" 1,	1862–63	1
Not bound, total........				3

The thanks of the Institute were voted to the donors.

III. *The following Paper was then read:*

By Prof. Kingston, M.A.:

" On the abnormal variations of the meteorological elements at Toronto, and their relation to the direction of the wind."

ELEVENTH ORDINARY MEETING.

5th March, 1864.

In the absence of the President, and the three Vice-presidents, on motion of Prof. Croft, seconded by Prof. Chapman the Rev. Dr. Scadding was called to the Chair.

I. *The following donations for the Library were announced, and the thanks of the Institute voted to the donors.*

FROM THE ROYAL SCOTTISH SOCIETY OF ARTS, EDINBURGH.

The Transactions of .... Vol. 6, Part 3, Pamphlet. 1

FROM THE AUTHOR, J. W. DAWSON, LL.D.

Flora of the carboniferous period of Nova Scotia....... 1*
On the Devonian Plants of Maine, Gaspe, and New York.. Nov. 1863 1*

FROM T. C. WALLBRIDGE, M.P.P.

Explorations de Quebec a Lac St. Jean 1*
Correspondence and documents referring to the clerk of the Peace, Montreal.......................... 1*
La Revue Canadienne, Tome Premier.................. 1*

II. *The following Paper was read:*

By Prof. D. Wilson, LL.D.:

"On some of the supposed traces of human art in the Post-pliocene strata."

Afterwards a discussion took place on the subject in which Prof. Chapman, Prof. Hincks, Dr. Tucker, Dr. Barrett and the Rev. Dr. Scadding took part.

The thanks of the meeting were then voted to Prof. Wilson.

TWELFTH ORDINARY MEETING.

12th March, 1864.

The President The REV. J. McCAUL, LL.D., in the Chair.

I. *The following donations for the Librbary were announced.*

FROM HAWARD COLLAGE.

List of nebulae and star clusters seen at the observatory 1847—1863 1*
On the new Form of the achromatic object glass, &c., by G. P. Bond 1*

FROM T. C. WALLBRIDGE, M.P.P.

Supplementary catalogue of the Library of Parliament 1*
List of Bills Introduced, &c., &c.................................. 1*

FROM FRANCE.

Annales des mines Tome IV. Livraison, 5 and 6 .... 2*

II. Prof. Chapman in default of regular papers gave two verbal communications. (1) "On a peculiarity connected with the presence of Phosphorus in Iron Wire." (2) "On certain distinctive characters of the Rhizopoda."

The thanks of the Institution were conveyed to Professor Chapman by the President for his communications.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—JUNE, 1864.

Latitude—43 *deg.* 39.4 *min. North. Longitude*—5 *h.* 17 *m.* 33 *s. West. Elevation above Lake Ontario,* 108 *feet.*

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resul't. Direction.	Velocity of Wind.					Rain in inches.	Snow in inches.
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M	2 P.M	10PM	ME'N		6 A.M	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N	6 A.M.	2 P.M.	10 P.M.		6 AM.	2 PM.	10 P.M.	Re-sul't.	ME'N		
					°	°	°	°	°												°							
1	29.598	29.600	29.605	29.6023	52.4	56.9	51.1	53.97	— 2.98	.329	.362	.289	.334	.84	.78	.75	.79	w b n	sw b w	Calm.	n 48 w	4.0	0.5	0.0	2.50	2.73	0.005	...
2	.626	.606	.638	.6268	50.0	61.6	50.0	54.30	— 2.97	.283	.335	.283	.285	.78	.61	.78	.67	n w	s b w	Calm.	n 63 w	5.2	4.0	0.0	2.36	3.72	...	...
3	.665	.664	.665	.6705	47.5	61.6	52.6	55.10	— 2.45	.245	.311	.310	.292	.74	.56	.78	.67	Calm.	s b e	s w b s	s 8 w	0.0	5.5	2.2	2.21	2.56	...	...
4	.684	.615	.514	.6025	53.6	68.1	54.7	58.57	+ 0.72	.329	.342	.294	.319	.80	.49	.68	.65	Calm.	s b w	n e	s 61 e	0.0	1.8	1.8	1.09	1.79	...	...
5	.482	.391	—	—	56.2	66.3	—	—	—	.360	.432	—	—	.80	.66	—	—	e s e	s e b e	Calm.	s 15 e	0.5	6.5	0.0	2.86	3.73	...	...
6	.332	.605	.770	.5972	61.9	57.6	44.3	53.00	— 5.45	.452	.224	.184	.250	.82	.46	.63	.60	w b s	n w	Calm.	n 40 w	11.2	16.8	0.0	10.62	10.79	Inp.	...
7	.869	.839	.849	.8523	41.7	63.4	49.0	52.57	— 6.18	.191	.310	.266	.260	.72	.53	.77	.66	Calm.	s s w	Calm.	s 22 w	0.0	9.0	0.0	3.49	3.54	...	...
8	.774	.569	.338	.5348	48.2	64.1	55.8	55.98	— 3.08	.277	.267	.377	.310	.82	.44	.85	.70	Calm.	s	s w b w	s 25 w	0.0	6.7	3.5	2.38	2.85	0.120	...
9	.074	.079	.302	.1625	59.1	64.5	50.0	56.90	— 2.57	.475	.431	.283	.379	.95	.71	.78	.79	s w b w	n w b n	n w b n	n 37 w	4.2	24.0	4.0	10.65	11.49	0.395	...
10	.484	.552	.597	.5507	45.3	51.8	44.3	47.45	—12.33	.200	.188	.176	.185	.65	.49	.60	.57	n w b n	n w b n	n w b n	n 35 w	13.3	11.0	5.8	9.24	9.27	..	...
11	.647	.657	.734	.6842	45.0	58.0	46.4	50.58	— 9.40	.185	.199	.221	.207	.62	.40	.70	.57	n n w	n w b w	n b e	n 38 w	1.0	10.8	4.8	4.43	5.77	...	...
12	.814	.856	—	—	47.2	56.9	—	—	—	.220	.232	—	—	.67	.49	—	—	n b w	s s w	n n w	n 31 w	10.3	5.8	6.5	1.46	5.12	...	...
13	.931	.873	.831	.8775	49.0	62.3	56.2	57.03	— 3.55	.256	.302	.285	.282	.74	.53	.63	.61	Calm.	s s w	s w b s	s 75 w	0.0	7.0	3.0	1.35	4.11	...	...
14	.823	.742	.681	.7393	51 5	67.3	60.5	61.22	+ 0.38	.263	.367	.325	.320	.69	.55	.61	.59	n	s w b s	Calm.	s 43 w	0.4	2.8	0.0	1.23	1.42	...	...
15	.667	.633	.576	.6273	56.2	74.2	67.0	65.50	+ 4.37	.285	.203	.264	.290	.63	.23	.39	.48	Calm.	s w	n b w	s 79 w	0.0	0.5	3.0	0.89	1.58	...	...
16	.586	.604	.613	.6092	57.6	76.0	69.1	69.98	+ 8.63	.309	.446	.305	.366	.64	.50	.43	.49	n b w	Calm.	Calm.	s 24 w	0.5	0.0	0.0	0.99	1.00	...	...
17	.678	.693	.676	.6832	65.9	77.5	67.4	71.33	+ 9.68	.374	.510	.340	407	.59	.54	.50	.52	Calm.	Calm.	Calm.	Calm.	0.0	0.0	0.0	0.00	0.00	...	...
18	.709	.661	.645	.6710	64.8	73.1	65.6	68.60	+ 6.65	.362	.444	.428	.416	.59	.55	.67	.59	Calm.	e s e	e s e	s 65 e	0.0	4.5	1.8	1.49	1.49	...	...
19	.681	.651	—	—	63.0	77.5	—	—	—	.386	.568	—	—	.67	.60	—	—	Calm.	s e b s	w n w	s 20 e	0.0	0.2	0.5	0.58	1.58	...	...
20	.718	.740	.772	.7460	62.7	77.5	67.0	70.85	+ 8.40	.504	.585	.409	.500	.88	.63	.61	.66	Calm.	e s e	e s e	s 86 e	0.0	8.2	2.0	1.92	3.35	...	...
21	.832	.836	.818	.8287	67.0	76.4	67.7	71.62	+ 8.95	.422	.539	.557	.530	.63	.59	.82	.68	n e	e	e b n	n 85 e	4.5	9.2	3.5	4.51	4.65	...	...
22	.803	.716	.682	.7257	65.2	85.4	70.6	74.20	+11.23	.550	.668	.603	.604	.88	.55	.81	.73	e n e	s w	w	s 83 w	0.5	4.0	2.7	2.09	3.33	...	...
23	.681	.665	.647	.6648	67.4	83.6	75.6	75.60	+12.45	.520	.709	.549	.606	.78	.62	.62	.69	w b n	s	n n w	n 29 w	0.2	5.5	5.8	2.12	4.05	...	...
24	.691	.601	.580	.6245	69.5	82.5	72.0	75.52	+12.17	.603	.661	.613	.627	.84	.59	.78	.71	n b w	s	e b n	s 10 e	1.0	4.5	1.8	0.30	2.71	...	...
25	.586	.511	.482	.5203	75.3	90.4	76.0	81.77	+18.22	.613	.602	.652	.625	.70	.41	.73	.60	w n w	w	s w b w	s 88 w	5.2	15.2	6.0	9.91	10.32	...	...
26	.477	.404	—	—	77.8	82.1	—	—	—	.629	.650	—	—	.66	.59	—	—	n w b w	s w b w	n w b n	n 57 w	8.6	13.0	15.8	8.56	11.60	0.050	...
27	.615	.726	.820	.7355	60.6	68.8	57.2	62.18	— 1.88	.414	.384	.188	.344	.78	.55	.40	.60	n n w	s s w	n n w	n 13 w	13.4	9.0	11.0	9.20	11.47	...	..
28	.931	.903	.846	.8942	55.4	67.7	54.7	60.30	— 3.98	.233	.197	.283	.244	.52	.29	.65	.48	n	s	s b w	s 24 e	4.8	8.0	2.0	2.98	4.34	...	...
29	.811	.717	.636	.7162	55.8	64.5	63.0	61.58	— 2.83	.269	.307	.424	.345	.60	.51	.74	.63	e e b e	e b n	Calm.	s 87 e	3.2	6.4	0.0	2.48	2.54	...	...
30	.507	.443	.482	.4688	65.9	82.9	70.2	73.23	+ 8.65	.514	.655	.497	.559	.80	.57	.67	.68	Calm.	s s w	n n w	s 44 w	0.0	5.2	0.5	1.55	2.92	...	...
...	...	...	...	...	...	...	...	...	...	...	...	—	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
M	29.6662	29.6481	29.6461	29.6545	57.49	69.91	59.92	63.03	+ 2.00	.364	.406	.362	.380	.73	.53	.67	.63	....	....	....	....	3.07	6.85	2.93	......	4.53	0.570	0.0

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR JUNE, 1864.

NOTE.—The monthly means do not include Sunday observations. The daily means, excepting those that relate to the wind, are derived from six observations daily, namely, at 6 A.M., 8 A.M., 2 P.M., 4 P.M., 10 P.M., and midnight. The means and resultants for the wind are from hourly observations.

Highest Barometer . . . . 29.961 at 8 a.m. on 28th. } Monthly range=
Lowest Barometer . . . . 29.007 at 11 a.m. on 9th. } 0.954 inches.

Self-registering Ther.:
- Maximum temperature . . . . 93°4 on p.m. of 25th } Monthly range=
- Minimum temperature . . . . 34°8 on a.m. of 7th } 58°6
- Mean maximum temperature . . 73°06 } Mean daily range=20°19
- Mean minimum temperature . . 52°87 }
- Greatest daily range . . . . . . 31°7 from a. m. to p. m. of 16th.
- Least daily range . . . . 7°2 from a. m. to p. m. of 6th.

Warmest day . . . 25th...Mean Temperature . . . 81°77 } Difference=34°32.
Coldest day . . . 10th...Mean Temperature . . . 47°45 }
Maximum { Solar (Vacuum) . . . . 133°2 on p. m of 25th } Monthly range=
Radiation { Terrestrial . . . . 24°8 on a. m. of 7th } 108°.4
Aurora observed on 5 nights, viz.:—on 7th, 9th, 10th, 11th and 28th.
Possible to see Aurora on 24 nights; impossible on 6 nights.
Raining on 5 days; depth 0.570 inches; duration of fall, 11.8 hours.
Mean of cloudiness=0.30, or 0.22 below average. Most cloudy hour observed, 6 a.m; mean=0.35; least cloudy hour observed, 10 p.m.; mean=0.23.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
1489.06	769.03	434.53	1444.69

Resultant direction, N. 55° W.; Resultant Velocity, 1.72 miles per hour.
Mean velocity 4.53 miles per hour.
Maximum velocity 27.5 miles, from 2 to 3 p.m. on 9th.
Most windy day 26th—Mean velocity 11.60 miles per hour. } Difference 11.60.
Least windy day 17th—Mean velocity 0.00 miles per hour. }
Most windy hour, 2 to 3 p. m.—Mean velocity, 7.45 miles per hour. } Difference
Least windy hour, 4 to 5 a.m.—Mean velocity, 2.15 miles per hour. } 5.30 miles.

7th. 5 a.m., hoar frost on the boarded footpaths, 10 p.m. to midnight; auroral arch, streamers, and pulsations.—9th. Thunderstorm, lightning and rain, 11.40 a.m. to 12.10 p.m.; auroral light at midnight.—10th. Faint auroral light at midnight.—11th. Faint auroral light at midnight.—22nd. Distant Thunder 11.40 a.m. to 12.30 p.m.—26th. Thunderstorm, lightning and rain 1.30 to 2.20 p.m.—28th. Auroral arch, band, and streamers, 9 p.m. and midnight.

Dew recorded on 11 mornings during this month.

June, 1864, was very warm, dry, clear, and calm. The depth of rain was the least recorded in any June during the series, being less than one-fifth of the average.

COMPARATIVE TABLE FOR JUNE.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above Average (45°5).	Maximum observed.	Minimum observed.	Range.	No. of days.	Inches.	No. of days.	Inches.	Resultant. Direction.	Resultant. Velocity.	Mean Force or Velocity
1840	59.8	— 1.5	78.5	37.1	41.4	11	4.860	...	...	...	...	...
1841	65.6	+ 4.3	92.8	45.7	47.1	9	1.560	...	...	...	...	0.36 lbs
1842	55.6	— 5.7	73.9	28.0	45.9	15	5.755	...	...	...	...	0.31 "
1843	58.4	— 2.9	81.3	28.5	52.8	12	4.595	...	...	...	...	0.27 "
1844	59.9	— 1.4	82.8	33.1	49.7	9	3.535	...	...	...	...	0.19 "
1845	61.0	— 0.3	83.6	40.9	42.7	11	3.715	...	...	...	...	0.27 "
1846	63.3	+ 2.0	83.3	41.5	41.8	10	1.920	...	...	...	...	0.32 "
1847	58.4	— 2.9	78.3	36.7	41.6	14	2.625	...	...	...	...	0.30 "
1848	62.9	+ 1.6	92.5	38.3	54.2	8	1.810	...	...	N 61 W	1.90	4.51 ms
1849	63.2	+ 1.9	84.9	45.2	39.7	7	2.020	...	...	S 71 E	0.49	3.32 "
1850	64.3	+ 3.0	83.2	49.0	34.2	10	3.345	...	...	S 60 W	0.38	4.54 "
1851	59.2	— 2.1	79.2	41.2	38.0	11	2.695	...	...	S 2 W	1.26	4.42 "
1852	60.8	— 0.5	86.1	43.6	42.5	10	3.160	...	...	S 76 W	1.49	4.09 "
1853	65.5	+ 4.2	86.3	43.3	43.0	9	1.550	...	...	N 1 W	0.10	3.73 "
1854	64.1	+ 2.8	88.7	47.4	41.3	9	1.460	...	...	N 24 E	0.71	4.15 "
1855	59.9	— 1.4	90.7	40.6	50.1	17	4.070	...	...	N 69 W	1.33	5.70 "
1856	62.1	+ 0.8	82.6	48.3	34.3	13	3.200	...	...	S 21 W	0.90	5.30 "
1857	56.9	— 4.4	75.1	40.9	34.2	21	5.060	...	...	N 49 W	1.15	7.60 "
1858	66.2	+ 4.9	86.3	48.7	37.6	12	2.943	...	...	S 20 E	0.25	5.53 "
1859	58.3	— 3.0	85.2	33.9	51.3	16	4.085	2	Inp.	N 77 W	1.95	7.19 "
1860	63.2	+ 1.9	81.1	50.0	31.1	14	2.136	...	...	N 44 W	3.13	7.61 "
1861	61.3	0.0	86.5	48.2	38.3	13	2.329	...	...	N 39 W	2.29	6.11 "
1862	60.5	— 0.8	83.2	44.3	38.9	10	1.007	...	...	N 26 W	1.77	5.98 "
1863	60.1	— 1.2	79.3	45.0	34.3	13	1.662	...	...	N 50 W	2.26	5.24 "
1864	63.0	+ 1.7	92.6	41.7	50.9	5	0.570	...	...	N 55 W	1.72	4.53 "
Results to 1864.	61.34	...	83.92	41.64	42.28	11.6	2.867	...	...	N 61 E	0.98	5.27
Exc. for 1864.	+1.69	...	+8.68	+0.06	+8.62	— 6.6	— 2.297	...	...	...	...	—0.74

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST.—JULY, 1864.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 min. 33 sec. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32°. 6 A.M.	2 P.M.	10 P.M.	MEAN.	Temp. of the Air. 6 A.M	2 P.M.	10 PM	ME'N	Excess of mean above Normal.	Tens. of Vapour. 6 A.M	2 P.M.	10 P.M.	M'N	Humidity of Air. 6 A.M	2 P.M.	10 P.M.	M'N	Direction of Wind. 6 A.M.	2 P.M.	10 P.M.	Resultant Direction.	Velocity of Wind. 6 A.M	2 P.M	10 PM	Resul't.	ME'N	Rain in Inches.	Snow in Inches.
1	29.531	29.496	29.421	29.4792	° 61.9	° 73.8	° 64.8	° 68.05	° + 3.28	.425	.604	.582	.555	.76	.72	.95	.81	N W b N	S S E	E b N	S 79° E	0.6	0.4	6.2	1.93	2.52	0.440	...
2	.319	.404	.479	.4067	67.0	71.0	60.1	66.82	+ 1.82	.636	.513	.439	.546	.96	.67	.84	.83	Calm.	W N W	W	N 71 W	0.0	17.4	2.0	9.82	10.04	0.007	...
3	.512	.511	—	—	58.0	70.2	—	—	—	.337	.291	—	—	.70	.39	—	—	W b N	W N W	W N W	N 65 W	10.2	19.2	5.3	12.66	12.69	...	...
4	.597	.610	.653	.6223	56.5	71.7	59.8	63.20	— 2.10	.313	.411	.291	.347	.68	.53	.56	.59	W N W	W N W	N b W	N 49 W	7.2	7.2	9.2	6.60	7.04	...	...
5	.737	.690	.626	.6770	55.8	76.0	66.3	67.48	+ 2.10	.310	.433	.482	.426	.70	.48	.74	.64	W N W	S	S W b W	S 22 W	3.5	10.0	2.2	4.96	5.65	...	...
6	.599	.542	.559	.5685	65.2	77.5	71.0	70.55	+ 4.95	.445	.569	.527	.513	.71	.60	.69	.63	S W b W	S b W	W N W	S 62 W	2.8	6.0	4.5	3.13	4.48	...	...
7	.517	.513	.505	.5127	65.9	67.0	63.4	65.32	— 0.38	.527	.498	.485	.500	.83	.76	.83	.80	E b N	N E	N E	N 47 E	6.5	6.5	1.0	5.07	5.82	0.065	...
8	.598	.683	.745	.6825	66.3	78.9	67.7	71.22	+ 5.43	.548	.450	.537	.507	.85	.45	.82	.69	N N W	S b E	N N W	S 37 E	3.0	6.2	4.5	0.50	3.53	...	...
9	.823	.777	.678	.7502	62.3	79.2	65.2	70.17	+ 4.18	.484	.487	.536	.516	.86	.48	.86	.72	Calm.	S b E	E	S 40 E	0.0	4.5	0.5	1.76	2.51	...	...
10	.595	.480	—	—	65.2	72.0	—	—	—	.536	.706	—	—	.86	.90	—	—	E	S E	S S W	S 18 E	0.5	3.0	1.0	0.98	1.52	0.165	...
11	.422	.375	.488	.4307	68.1	77.5	68.1	72.72	+ 6.53	.594	.388	.433	.489	.87	.41	.62	.63	S S W	S W b S	N W	N 85 W	2.2	16.8	9.5	7.89	10.80	...	...
12	.568	.645	.743	.6633	64.5	75.8	64.8	68.58	+ 2.28	.454	.407	.280	.376	.75	.46	.46	.54	N N W	N N W	N b W	N 17 W	5.0	12.4	10.5	10.22	10.48	...	...
13	.807	.803	.792	.8040	61.6	73.8	67.3	68.35	+ 1.97	.346	.434	.418	.416	.63	.52	.61	.60	N	S S W	S W b S	S 60 W	8.8	7.7	4.2	1.64	5.01	...	...
14	.805	.765	.721	.7608	60.9	79.3	68.1	71.03	+ 4.62	.402	.374	.459	.423	.74	.37	.67	.57	N b W	E S E	E b S	S 88 E	3.0	5.0	3.5	3.73	4.47	...	...
15	.737	.700	.687	.7048	66.6	82.9	65.2	72.23	+ 5.75	.490	.556	.484	.512	.74	.49	.77	.66	N E	S b E	E	S 72 E	4.0	3.4	0.8	2.05	3.80	...	...
16	.691	.667	.677	.6802	65.9	84.7	74.9	76.62	+10.03	.514	.548	.517	.536	.80	.46	.59	.59	N W	S b E	N W b W	S 1 W	0.2	6.0	3.8	0.77	4.08	...	..
17	.755	.773	—	—	70.6	80.3	—	—	—	.518	.575	—	—	.69	.56	—	—	E b N	E S E	E b N	N 79 E	3.0	5.8	5.0	3.85	4.48	...	...
18	.806	.811	.783	.7947	68.8	83.9	72.0	75.33	+ 8.65	.542	.561	.598	.595	.77	.48	.76	.69	N E	S S E	E S E	S 65 E	2.8	5.5	4.4	3.16	3.67	...	...
19	.831	.722	.629	.7208	71.3	85.8	71.3	76.67	+ 9.88	.622	.520	.566	.552	.81	.42	.73	.63	S S W	S	S W b S	S 13 W	0.5	8.8	2.0	4.37	4.51	...	...
20	.554	.504	.600	.5568	68.4	85.4	68.8	73.83	+ 7.07	.520	.392	.434	.444	.75	.32	.62	.56	S W b S	W b N	N W b N	N 48 W	0.4	21.5	12.0	12.02	13.01	...	...
21	.721	.704	.701	.7120	58.0	68.8	58.0	61.42	— 5.35	.337	.205	.208	.256	.70	.29	.43	.49	N N W	N N W	N W b N	N 28 W	7.2	18.5	14.0	13.77	13.82	...	...
22	.766	.698	.735	.7300	57.6	72.4	55.5	62.72	— 4.15	.276	.203	.262	.235	.58	.25	.59	.44	N N W	N W	N W b N	N 37 W	6.5	15.2	0.8	8.57	8.63	...	...
23	.741	.692	.706	.7077	52.9	78.9	64.5	66.22	— 0.67	.274	.407	.319	.343	.69	.41	.53	.54	N W b N	S S W	W N W	S 73 W	1.8	7.2	2.8	3.73	5.10	...	...
24	.730	.688	—	—	60.9	77.1	—	—	—	.378	.487	—	—	.70	.52	—	—	W N W	Calm.	E S E	S 51 E	1.5	0.0	4.0	2.18	3.83	...	...
25	.642	.538	.469	.5458	63.4	72.4	62.3	65.75	— 1.22	.483	.494	.497	.490	.82	.62	.88	.78	N E b E	E b N	N W b N	N 1 W	5.2	7.0	13.5	3.46	7.81	0.330	...
26	.533	.596	.664	.6095	62.3	76.0	65.2	66.80	— 0.17	.510	.615	.577	.556	.90	.68	.92	.85	N N E	S S W	S S W	S 68 W	2.5	5.2	1.4	3.27	5.10	0.215	...
27	.739	.714	.738	.7302	60.5	79.3	70.6	71.13	+ 4.15	.484	.639	.589	.562	.92	.63	.79	.74	W N W	S S W	N b W	S 65 W	2.0	7.5	3.5	1.92	3.62	...	...
28	.695	.552	.459	.5520	63.7	86.1	73.1	75.33	+ 8.37	.491	.518	.614	.563	.83	.42	.75	.67	N b W	W b S	W	S 80 W	0.5	15.0	12.0	7.12	8.38	0.010	...
29	.508	.486	.459	.4862	67.0	78.5	71.3	72.40	+ 5.45	.553	.469	.524	.511	.83	.47	.68	.65	W N W	S b W	N N E	N 37 W	1.0	5.0	6.8	2.05	4.50	...	...
30	.471	.458	.455	.4642	65.2	80.3	68.1	73.12	+ 5.83	.497	.531	.551	.535	.79	.51	.80	.66	N	S b W	Calm.	S 16 W	0.5	5.4	0.0	1.37	1.75	...	...
...	.492	.448	—	—	69.2	87.9	—	—	—	.565	.653	—	—	.79	.49	—	—	Calm.	S E b S	S	S 18 W	0.0	5.0	1.9	2.45	3.25	0.100	...
M	29.6445	29.6210	29.6220	29.6289	63.37	77.57	66.44	69.73	+ 3.48	.464	.470	.470	.473	.78	.50	.71	.66	....	....	....	....	3.00	8.53	4.93	....	6.00	1.332	...

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR JULY, 1864.

Note.—The monthly means do not include Sunday observations. The daily means, excepting those that relate to the wind, are derived from six observations daily, namely at 6 A.M., 8 A.M., 2, 4 and 10 P.M., and midnight. The means and resultants for the wind are from hourly observations.

Highest Barometer........29.831 at 8 a.m. on 9th; 6 a.m on 19th } Monthly range =
Lowest Barometer ....29.319 at 6 a.m. on 2nd } 0.512 inches.

Self-registing Thermom.
- Maximum Temperature ....90°2 on p.m. of 31st } Monthly range=
- Minimum Temperature ....49°0 on p.m. of 5th } 41°2
- Mean maximum Temperature .... 79°95 } Mean daily range=
- Mean minimum Temperature .... 59°79 } 20°16
- Greatest daily range ......31°2 from a.m. to p.m. of 23rd.
- Least daily range............ 5°6 from a.m. to p.m. of 7th.

Warmest day ....19th... Mean temperature........... 76°67 } Difference = 15°25.
Coldest day .... 21st... Mean temperature .... 61°42 }
Maximum Radiation. { Solar.................................. 130°0 on p.m. of 16th } Monthly range =
{ Terrestrial.......................... 39°0 on a.m. of 5th } 91°0
Aurora observed on 3 nights, viz.,—on 12th, 18th and 19th.
Possible to see Aurora on 19 nights; impossible on 12 nights.
Raining on 8 days, depth 1.332 inches; duration of fall 24.7 hours.
Mean of cloudiness = 0.44; below average 0.04.
Most cloudy hour observed, midnight; mean = 0.47; least cloudy hour observed, 8 a.m.; mean, = 0.40.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
1836.42	1041.46	710.63	2166.12

Resultant direction N. 61° W.; Resultant velocity 2.23 miles per hour.
Mean velocity ....6.00 miles per hour.
Maximum velocity .... 23.4 miles, from 3 to 4 p.m. on 20th.
Most windy day ......21st............Mean velocity, 13.82 miles per hour. } Difference=
Least windy day ...10th............Mean velocity, 1.52 ditto } 12.30 miles.
Most windy hour ... noon to 1 p.m.........Mean velocity, 9.43 ditto. } Difference=
Least windy hour ...5 a.m. to 6 a.m.........Mean velocity, 3.13 ditto. } 6.30 miles.

1st. Sheet lightning in S.E. at 10 p.m.—2nd. Fog at 6 and 8 a.m.—6th. Distant thunder 5 to 7 p.m.—9th. Solar halo at 5 p.m.—10th. Thunderstorm noon to 1 p.m.—12th. Auroral arch and streamers at midnight.—18th. Auroral arch, patches and streamers from 1 a.m.—19th. Auroral patches and streamers 10 to 10.30 p.m.—26th. Fog 6 to 8 a.m.; thunderstorm 3 to 4 p.m.—28th. Thunderstorm 8.20 to 9.45 p.m.—29th. Sheet lightning in S. and S.W. at 10 p.m.—30th. Sheet lightning in N.W. 10 p.m. and midnight.—31st. Thunderstorm 4 to 6 p.m.

July, 1864, was comparatively warm, dry, windy, and clear. The Rain recorded was less than half the average.

Heavy dew recorded on the 5th, 9th, 11th, 19th, and 28th.

COMPARATIVE TABLE FOR JULY.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above aver'ge (26.1)	Max. ob-served.	Min. ob-served.	Range.	No. of days.	Inches	No. of days.	Inches	Resultant. Direction.	Resultant. V'y.	Mean Force or Velocity.
1840	° 65.8	° — 1.2	° 79.4	° 48.2	° 31.2	6	5.270	...	...	...	...	....
1841	65.0	— 2.0	86.3	43.2	43.1	10	8.150	...	...	...	...	0.27lbs.
1842	64.7	— 2.3	90.5	42.0	48.5	4	3.050	...	...	...	...	0.33
1843	64.5	— 2.5	86.1	40.2	45.9	8	4.605	...	...	...	...	0.44
1844	66.0	— 1.0	86.1	40.5	45.6	12	2.815	...	...	...	...	0.19
1845	66.2	— 0.8	94.6	45.6	49.0	7	2.195	...	...	...	...	0.30
1846	68.0	+ 1.0	94.0	44.9	49.1	9	2.895	...	...	...	...	0.29
1847	68.0	+ 1.0	87.5	43.8	43.7	8	3.355	...	...	...	...	0.19
1848	65.5	— 1.5	82.7	46.7	36.0	10	1.890	...	...	N 14° W	0.18	4.94mls.
1849	68.4	+ 1.4	89.1	51.0	38.1	4	3.415	...	...	S 5° W	0.75	5.52
1850	68.9	+ 1.9	84.9	52.8	32.1	12	5.270	...	...	N 81° E	0.59	4.56
1851	65.0	— 2.0	82.7	52.1	30.6	12	3.625	...	...	N 60° W	0.88	4.13
1852	66.8	— 0.2	90.1	49.5	40.6	8	4.025	...	...	N 43° W	0.93	3.33
1853	65.6	— 1.4	85.4	49.4	36.0	10	0.915	...	...	S 58° E	0.24	3.69
1854	72.5	+ 5.5	93.6	53.0	40.6	9	4.805	...	...	S 49° W	0.37	4.03
1855	67.9	+ 0.9	88.4	53.1	35.3	13	3.245	...	...	S 19° W	0.73	6.47
1856	69.9	+ 2.9	92.0	51.4	40.6	8	1.120	...	...	N 79° W	1.57	5.84
1857	67.8	+ 0.8	85.4	52.4	33.0	15	3.475	...	...	S 68° E	0.81	4.74
1858	67.9	+ 0.9	83.4	55.9	27.5	13	3.072	...	...	N 15° E	1.13	5.76
1859	66.9	— 0.1	87.7	50.5	37.2	12	2.611	...	...	N 56° W	1.48	5.81
1860	63.9	— 3.1	85.8	47.5	38.3	13	4.336	...	...	N 60° W	2.15	7.29
1861	65.4	— 1.6	82.9	49.4	33.5	16	2.635	...	...	N 74° W	1.43	4.66
1862	36.7	— 0.3	88.6	52.6	36.0	15	5.344	...	...	S 89° W	1.42	5.80
1863	67.6	+ 0.6	82.3	49.3	33.0	15	3.408	...	...	N 18° W	0.40	3.89
1864	69.7	+ 2.7	87.9	52.9	35.0	8	1.332	...	...	N 61° W	2.23	6.00
Results to 1864.	66.98	...	87.10	48.72	38.38	10.3	3.474	...	...	N 66° W	0.63	4.97
Exc. for 1864.	+ 2.75	...	+ 0.80	+ 4.18	— 3.38	— 2.3	— 2.142	...	...	....	......	+ 1.03

THE

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THE CANADIAN JOURNAL.

NEW SERIES.

No. LIV.—NOVEMBER, 1864.

INQUIRY INTO THE PHYSICAL CHARACTERISTICS OF THE ANCIENT AND MODERN CELT OF GAUL AND BRITAIN.

BY DANIEL WILSON, LL.D.,

PROFESSOR OF HISTORY AND ENGLISH LITERATURE, UNIVERSITY COLLEGE, TORONTO.

Among the terms of a distinctive ethnical significance, derived from classical authorities, and applicable to living races, few have been employed more loosely and indefinitely than that of *Celt*. The causes of this arise, in part, from the great antiquity of what appears on many accounts to have a just claim to be ranked as the oldest member of the Aryan family of European nations. The peculiar relations traceable between the various Celtic dialects and any assumed common mother tongue of all the Indo-European languages, appear to indicate that the former separated at an earlier stage than the classical languages. I have assigned reasons in a former paper* for believing that the historic advent of the Gauls, on their invasion of Rome and Central Italy in the fourth century, B. C., so far from indicating their first appearance in Europe, in reality marks the commencement of their decline and decay. They were then beginning,

* *On the Intrusion of the Germanic Races into Europe.* Edin. Philosoph. Jour. N. S. January, 1855.

as I conceive, to be displaced in central Europe, by the movements of the Germanic nations from beyond the Baltic into their later home in the Rhine valley.

In the time of Herodotus, the Greeks knew vaguely of a people called Κέλται, occupying the remotest regions of Europe, bordering on the Atlantic. At later dates allusions are made to them by Xenophon and Aristotle; and the latter indicates an increasing knowledge of them in his day, by the references to their customs and most characteristic traits which occur in his philosophical works. But the very imperfect knowledge of this ancient people manifested by the most observant Greek writers, suffices to illustrate the extreme isolation of the nations within the period of authentic history. Transalpine Europe was still a *terra incognita*; and the Κέλται, whose language is the key to much of the earliest topographical nomenclature of Central Europe, from the Atlantic to the head of the Adriatic Gulf; and who must have been a numerous and powerful people long before they made their hostile incursions into Italy: were, nevertheless, known only to the Greeks through some obscure rumours, probably of Phœnician voyagers. Slight, however, as are the early notices of the Keltai, they reveal to us the presence at the dawn of authentic history of that remarkable people who seem to constitute a link between the prehistoric and the historic nations of Europe. If we do indeed look upon them for the first time in the beginning of their decline, when younger nations were already intruding on the ancient Celtic area, and effecting the first encroachments which finally resulted in their dismemberment and denationalisation: it suffices to illustrate the great age of nations. Upwards of two thousand years have since elapsed; and still the fragments of that once powerful branch of the European family of nations preserve their ancient tongue, and struggle to assert for themselves an independent nationality. To the Romans they had made themselves known as haughty conquerors, while yet the imperial city on the Tiber was but the nucleus of an infantile state; but the earliest authentic details regarding them, as the occupants of what is regarded as their native territory, are derived from the narrative of Cæsar's conquests; and the subsequent reduction of the tribes of Gaul and Britain by the Legionaries of Rome.

Unfortunately the ethnologist has at every step in his researches, to deplore the indefiniteness of nearly all the notices of the barbarian races with which the Greeks or Romans were brought into contact;

and in seeking their aid to determine the physical characteristics of Kelt, Gaul or Briton, the results are little less vague, than when he attempts to fix the ethnical character of the Pelasgi, or to group the Etrusci among indigenous races of Italy. The controversies, moreover, of which the term *Celtic* has furnished the key-note, were long embittered by the narrowest spirit of national prejudice, and exposed thereby to well-merited ridicule.* One recent champion of the Celt, in a communication to the British Association, after characterising the Saxon as "a flaxen-haired, bullet-headed, stupid, sulky boor," proceeds to define the Celtic characteristics recognisable in men who have taken a distinguished place in English or Scottish history, as "a long cranium, high and expressive features, dark or warm complexion, and spare or muscular frame."† Pinkerton the Teutonic partizan,—who, in like fashion, maintained the opposite side in this controversy, by affirming: "What a lion is to an ass, such is a Goth to a Celt;"—assigns to the latter: dark hair and eyes, swarthy complexion, and inferior stature to the large-limbed, red or yellow-haired Goth, with fair complexion and blue eyes. In so far as the form of the head marks the difference between them, the supposed cranial contrast is indicated in the globular or "bullet-head" assigned to the Saxon, and the long cranium and high features ascribed to the Celt. The latter, at least, is an idea maintained, with more or less definiteness, by some of the most observant ethnologists; and so long as the Celt was supposed to belong to an essentially different division of the human race, it was not unnatural to assume that the opposite type of head must pertain to the Saxon. Few points, however, connected with physical ethnology rest on more uncertain evidence than the distinctive form, colour of hair, and other characteristics, not only of the ancient, but of the modern Celt.

The Gauls and Britons are the recognised representatives of that ancient people, who after being long regarded as in the most literal sense European aborigines, are even now commonly assumed to be the originators of all primitive art-traces pertaining to purely archæolo-

* The only occasion where Dr. Prichard is tempted beyond the simple language of the scientific investigator is where, in his *Researches*, he contrasts Pinkerton's views as a man "of clear and strong sense, though somewhat peremptory and wrong headed;" with "the weak and childish dreams of the Celtic antiquarians *who descant with amazing absurdity, through entire volumes, upon their Phœnician, Punic, Scythian, Spanish, and Magogian ancestry!*"

† Mr. John McElheran.

gical, in contradistinction to geological researches. Of this, however, there is not only no proof, but the existence of pre-Celtic races, to whom the implements and arts of the European Stone Period were assignable, had been maintained both on technological and philological grounds, before the traces of Cave-Men, or the Flint-Folk of post-pliocene ages, had been demonstrated by the geologist, from evidence derived to a great extent from the French drift, where it is overlaid by the graves and buried arts of the ancient Gaul and his Roman conqueror.

From the date of Julius Cæsar's conquests, the native population both of Gaul and the British Isles have been made the subjects of descriptive comment by some of the most observant writers. But their notices of the tribes on both sides of the English Channel, suffice to remind us, that in speaking of the Celts we are not dealing with an isolated and homogeneous people, but with diverse nations of a common race, which once filled Central Europe; and which, moreover, in the earliest period of their definite history, were the occupants of a diminishing area, encroached upon by Germanic and other nations, before the Romans stepped in to complete the changes already in progress. There were Gauls or Kelts to the south, and to the east of the Alps, to the south of the Pyrenees, to the north of the English Channel, and—according to archæological evidence,—seemingly even to the north of the Baltic sea. Among the numerous tribes of a common stock thus brought into contact with the most diverse races of Europe, we must anticipate considerable variations from any assignable type. But this contact has been of a far closer and more influential character since the fall of the Roman Empire; so that it is little more difficult to ascertain what were the specific characteristics of the ancient Gaul or Briton, than it proves to be to determine the typical attributes of the modern continental or insular Celt. Few races of European origin, for example, show less indications either of physical or moral affinity than the so-called French and Irish Celts of Lower Canada: the one warm-hearted, but irrascible, pugnacious, and prone to excitement; the other gentle, impassive, and amiable to a fault. How far the common term is applicable to both will be considered on a subsequent page.

Cæsar's account of the Gauls in the sixth book of his *Bellum Gallicum* supplies the most comprehensive details we now possess in reference to their manners and religion; and to him also we owe similar

notices of the Belgæ and other continental tribes, seemingly most nearly allied to others of south Britain, the Germanic or Celtic affinities of which have been made the subject of much controversy among modern ethnologists. In the previous book* Cæsar expressly states that, while the inhabitants of Britain are regarded as aborigines, the sea coast is occupied by tribes derived from the country of the Belgæ, and bearing names corresponding to those of the states they came from. Strabo describes the Britons of about the commencement of the following century, in part from observations made on some of their young men seen by him at Rome; and he discriminates between them and the Gauls, assigning to the latter yellow-hair, a fairer complexion, and smaller stature, than their insular neighbours.* This suggests a comparison with the description of the Caledonians given by Tacitus, in which he notes the huge stature and red hair of the latter, and recognises in them an approximation to the German type.* The Silures, or West Britons, on the contrary, he contrasts both with them and the southern tribes, as *colorati vultus et torti plerumque crines;* they were of florid, or, rather in this case, dark complexion, with abundance of curly locks; and to this Jornandes adds that the hair was black. They thus contrasted very strikingly both with the northern and southern tribes; and Tacitus, in referring to an Iberian origin ascribed to them, adds the probable confirmation arising from the position of their country, standing as it does opposite to Spain. To the southern Britons alone, a common origin with the Gauls was assigned; though Tacitus himself recognises the correspondence between the whole of those insular tribes and the continental Gauls, in customs, language, and religious rites; and obviously attaches more importance to these points of agreement, than to those of physical difference.

The allusions to varieties of physical character, are so far valuable, though deficient in many important details. Virgil, Claudian, and other poets repeat them, but without enlarging their details, or adding to their credibility; and when every reference has been carefully weighed, it is surprising how little that is definite can really be inferred beyond the one important fact that considerable diversity prevailed. So vague is all that can be deduced from such references, that Nieb-

* *Bell. Gall.* lib. v. c. 12.

† *Strabo*, lib. iv.

‡ *Vit. Agricola*, c. xi.

hur, Prichard, Laurence, Latham, and other writers, have debated the questions: were the Gauls xanthous or swarthy; yellow, red, or dark-haired; and blue or black-eyed? and of the Britons, in like manner, it is still a moot point, whether they were fair or dark, and their long shaggy locks were black, brown, red, or yellow. Dr. Beddoe, an intelligent observer, applied the test of personal experience, a few years since, to determine some of the same questions; and found it little less puzzling to arrive at any definite results in reference to their modern representatives, than to reconcile conflicting evidence relative to the Celts or Gauls of two thousand years ago.* Niebhur, confounded by the assurance conveyed to him by an English correspondent, that all modern British Celts have black hair: in the last edition of his Roman History, places this supposed fact in contrast with the yellow hair assigned by Ammianus Marcellinus, a resident in Gaul, to the continental Celts. Dr. Beddoe, on the contrary, was forced at last to the conclusion "that black and red hair are not so diametrically opposed as is generally imagined;" and he ended by assigning to the British Celt:—eyes grey or blue, passing through dark grey into brown and black; hair bright red or yellow, passing through various shades of bright brown, into dark brown and coal black. The Teutonic Briton differed in the red hair being light, and the yellow flaxen; while the brown tints were dull; and neither eye nor hair exhibited the pure black.

Difficult as it thus appears to be to determine the complexional peculiarities of the Gaul or Briton, either of ancient or modern times: it might seem an easier task to define the form of head characteristic of each. The light of their eyes may be quenched in dust, and the bright locks have yielded up their lustre to the grave; but the skull, though not imperishable, has in many cases resisted decay. Of the Roman supplanters of the Gaul and Briton, many skulls are preserved; some of which, recovered from inscribed sarcophagi, not only reveal the race of the deceased, but the name, age, rank, and term of military service or foreign residence of each. When we turn to the contemporary Gaulish or British barrow, we look in vain for information so minute or exact. Nevertheless, the evidence is sufficient for all practical requirements, and it is indisputable that hundreds of Crania have been

* *A Contribution to Scottish Ethnology:* by John Beddoe, B.A., M.D.; London 1853. *On the Ancient and Modern Ethnography of Scotland.* Proceed. Soc. Antiq. Scot. Vol. I. p. 256.

recovered from French and English grave mounds, contemporary with the era of Roman occupation.

It may be assumed as a recognized fact, that the form of the human skull is essentially distinctive of race. The difficulty is to determine the characteristic differentiæ, especially in approximate races; and hence considerable diversity of opinion still prevails as to the methods best fitted to express the ethnical significance of form, proportions, prognathism or orthognathism, and other characteristic diversities. But as the study of craniology, and anthropology generally, continues to receive ever increasing attention, the simple broad distinctions, such as those which satisfied Blumenbach or even Retzius, disappear; and now we have brachycephalic, dolichocephalic, kumbecephalic, scaphocephalic, macrocephalic, sphenocephalic, acrocephalic, and platycephalic skulls, with numerous subordinate modifications. Of those forms, five, at least, occur among ancient British crania; and include types of extreme diversity. To some of these I have already repeatedly referred in former papers; and have indicated in other publications some of the grounds that lead me to infer the existence, at some remote period, of races distinct from the Celtic tribes found in occupation of the British Islands, at the period of Roman invasion.*

Briefly, the evidence already set forth points to a megalithic era, with huge chambered catacombs of cyclopean masonry, and traces of a race remarkable for long, narrow heads, moderately developed zygomata and cheek bones, and small under jaws, as their builders. To this it is objected that by assigning priority to the constructors of the elaborate and massive chambered catacombs over the simpler barrow builders, the probable order in the succession of constructive remains is inverted. This idea, however, proceeds on the assumption that primitive arts must invariably proceed from the rudest to more ingenious and elaborate works. The recently discovered carvings and engravings, found by M. Lartet and Mr. Christie in the Dordogne Caves, of Central France, rude though they are, suffice to prove that artistic ingenuity is no modern acquisition of man. But we are dealing with races nearer the confines of the historic period than the contemporaries of the Reindeer of Central France. The cyclopean cata-

* *Ethnical forms and undesigned artificial distortions of the Human Cranium.* Canadian Journal, Vol. VII. p. 399. *Illustrations of the significance of certain Ancient British skull forms.* Ibid. Vol. VIII. p. 127. *Prehistoric Annals of Scotland.* Sec. Ed. pp. 227–298, &c.

combs of the British Kumbecephali have no claims to a primeval rank among the recovered traces of early human arts. Supposing them to be three, four, or five thousand years old, grave-mounds, barrows, and tumuli of every form and proportion may have preceded them, and been erased. Neither history nor definite archaeology, moreover, confirms any such "natural order." On the contrary, in Egypt, India, Greece, and Italy; in Peru, Central America, and even in some of the islands of the Pacific, the oldest traces of architectural or constructive efforts survive in megalithic remains, ascribed for the most part to unknown and ante-historical races. Less substantial mounds or catacombs, which may have preceded or accompanied them, necessarily experienced the fate of all ephemeral structures; and it is probably mainly due to the cyclopean masonry of the chambered-barrow builders, that any evidence of the physical characteristics of so ancient a race are still recoverable.

But to this race succeeded a short-headed one, the Brachycephali of the later tumuli, which apparently survived in Britain to Roman times. The characteristic skull-form of this period has been repeatedly defined; and the significance of the vertical or obliquely flattened occiput of frequent occurrence, has been repeatedly discussed by me in former communications to the Canadian Institute. The point specially to be noted at present is, that not only considerable variations from any assumed typical British or Celtic cranium occur; but that at least two types of the most striking diversity mark the sepulchres of the megalithic era, and the seemingly later earth-barrows and cists. Their relative chronology is not indeed of permanent importance in the present inquiry. Both undoubtedly occur in ante-Christian and ante-Roman sepulchres. In referring to the doctrine of a pre-Celtic population for the British Islands, maintained in my "Prehistoric Annals of Scotland," Dr. Thurnam remarks: "Previous to inquiry as to the form of the skull in any possible pre-Celtic race, it is necessary to determine the form of the Celtic skull itself. Proceeding from the known to the unknown, we may then hope to trace the form of the skull in races which may possibly have preceded, or been mingled with the early Celtic population of Britain."* If possible, this is unquestionably most desirable; but as Dr. Thurnam here assumes that there is

* *Crania Britannica.* Chap. V. p. 55. The author adds, "such an inquiry is an important object of the present work." But the concluding Decade, with its summary of results from the accnmulated evidence is still unpublished.

a specific Celtic skull-form, both the above forms—to the correct knowledge of which he has largely contributed,—cannot be grouped under it. At least two types of extreme diversity belong to the ancient British pagan period: the one, the extremely long skull of the megalithic tombs; the other, the short aud broad brachycephalic skull abounding in British barrows of ante-Roman and Roman centuries; while the ovoid dolichocephalic skull of the pagan Saxon is intermediate in form, when compared with the two.

More than one hypothesis is open to us to account for such diversities. There is the probability of an Allophylian, possibly Finnic, Turanian, or other prehistoric race, which was in occupation of Britain before the first Celtic immigration. Retzius from the examination of two Basque skulls was led to the conviction, which accorded with his preconceived opinions, that the Basque head-form is brachycephalic. M. A. d'Abbadie confirmed this opinion by his observations on the living head; and the result has been generally accepted as an established fact. But recently, two members of the Anthropological Society of Paris recovered with their own hands, from a Basque cemetery, in the province of Guipuscoa, sixty crania, which are now deposited in the museum of the Society. Of these, M. Paul Broca remarks, in his address delivered before the Society in 1863: "Of the sixty Basque skulls in your collection, two or three only are really brachycephalous; most of them are altogether dolichocephalous; and, what was quite unexpected, the mean type of the series is much more dolichocephalous than that of the French in the north." Here it is seen M. Broca unhesitatingly styles them "Basque skulls;" but though the old Iberian tongue survives in the Basque district, its race may be, and probably is, not less mixed than the Gaelic speaking people of the Lewes, for example, among whom both Finnic and Norse features and head-forms are affirmed by one recent experienced observer, Captain Thomas, R.N. to predominate.* The unexpected results of the anatomical study of so large a number of crania from a cemetery within the Basque area, are, however, deserving of the most careful study. They help to add to the regret that the abundant dark locks of the Silures prevented Tacitus from reporting on the form of head of the British tribes to whom an Iberian origin was ascribed.

To the comparative proportions of the head-forms of Guipuscoa and the north of France I shall again refer. But, returning meanwhile to

* M.S. Letters to the author. *Prehist. Annals*, Vol. II. p. 208.

the diverse ancient British forms: another opinion specially maintained by Dr. J. Barnard Davis, is, that the brachycephalic head of the barrows is the true Celtic skull-form, and that all others, not Anglo-Saxon,—including even the Kumbecephalic crania of the megalithic tombs,—are mere exceptional deviations, or what he styles "aberrant forms." A third hypothesis may be started, which would receive confirmation from the opinions advocated by one class of ethnologists on philological grounds, that the Cymri and the Gaels are two essentially distinct races;* in which case the two very diverse forms of head may be physical tests of the two races. A fourth idea cannot be overlooked, in reference to some points discussed in subsequent pages, that the head of the Gaul and the British Celt may have undergone modifications in the course of time, wholly apart from any admixture with other races. One other opinion, in special favour among certain purely philological ethnologists, need not be discussed here, viz.: that craniology is valueless for ethnical classification.

Looking meanwhile to the osteological evidence derived from the British Islands, this much appears to be established, that at some remote period, lying beyond the earliest glimpses of any definite British History, the Kumbecephalic, or long headed race, occupied Britain in such numbers as to be capable of the combined labour required in the construction of vast chambered cairns and barrows. These sepulchres I cannot doubt are the mausolea of a royal or priviledged class, and not common receptacles of the dead. They exhibit the laborious but unskilled architecture of a megalithic era, lavished ungrudgingly on the sepulchres of the honoured dead. The only works of art found in them, or at least appearing strictly to belong to their original contents, are bone and flint implements, and rude pottery. This race, as appears from some of the crania recovered from the megalithic chambers, was not altogether ignorant, at some period of its presence in Britain, of another, characterised by an essentially different form of head. The circumstances under which the latter have been met with seem to justify the opinion that this Brachycephalic race occupied a servile relation to the other. When, however, we pass into a later, but still prehistoric era, the long-headed race disappears; and the simple earth-barrow and small cist characteristic of the latter race, reveal almost exclusively the brachycephalic

* *Celtic Language in reference to Race;* by John Crawford, Esq., F.R.S. *On the Gaels and Celts;* by M. Lagneau, &c.

type of skull, with prominent parietal tubers and truncated occiput. This is the form chiefly occurring in native British graves of the Roman period ; and on this, as well as on other grounds, it is assumed by Dr. J. B. Davis and others to be the true type of the British Celt. I have already advanced reasons for thinking that a race of Brachycephali, Turanian or other, to whom the rude stone arts of prehistoric Britain chiefly pertained, intervened between the Kumbecephali of the long chambered barrows and the true Celtæ.* The linguistic affinities between the latter and the great Aryan family of nations, prove that the Celtæ branched off from the parent stock subsequent to the evolution of numbers, the development of metallurgy and many other arts of civilisation. The contents of the earlier cairns, cromlechs, and barrows, do not therefore correspond with their progress ; and the very term *cromlech*,—gael. *cromadh*, Wel. *cromen*, a *roof* or *vault*, and *clach*, or *lech*, a stone :—indicates as total ignorance of its sepulchral character, as the English name : Druidical Altar.

In this state of the question it becomes a matter of interest to ascertain what direct evidence is still accessible, and how far it can be made available for throwing light on the physical, and more especially the cranial characteristics of the Celt.

One form of the Anglo Roman period—the historical age of Celtic Britain,—undoubtedly approximates to the brachycephalic type, notwithstanding many aberrations. But on the other hand this is by no means the predominant skull-form of the modern Welchman, the Highlander of the most purely Celtic districts of Scotland, or the seemingly unadulterated native population of south-western Ireland. On this subject Dr. Anders Retzius remarks : " During an excursion in Great Britain in 1855, I was able to satisfy myself anew that the dolichocephalic form is predominant in England proper, in Wales, in Scotland, and in Ireland. Most of the Dolichocephalæ of these countries have the hair black, and are very similar to Celts."† The Anglo-Saxon cannot be affirmed to be a pure race. Apart from later Danish, Norse, and Norman intermixture : it differs mainly, as I conceive, from its Germanic congeners, by reason of a large admixture of Celtic blood, traceable primarily to the intermarriage of Anglish and Saxon

* *Prehistoric Annals of Scotland*, sec. ed., vol. 1. part I., chap. IX. *Canadian Journal*, vol. VII., p. 405.

† *Archives des Sciences Physiques et Naturelles*, Geneva, 1860, *Smithsonian Report*.

colonists with the British women. Such a process of amalgamation is the inevitable result of a colonisation chiefly male, even where the difference is so extreme as between the white and the red or black races of the New World. But the Anglo-Saxon intruder and the native were on a par physically and intellectually; and while the former was pre-eminent in all warlike attributes, the latter excelled in the refinements of a civilisation borrowed both from the pagan Roman and the Christian missionary. There was nothing therefore to prevent a speedy and complete amalgamation. But if this was an admixture of a dolichocephalic with a brachycephalic race, the result should be a hybrid skull of intermediate form; whereas the modern Anglo-Saxon head is essentially longer than the continental Germanic type. This, therefore, seems to me to point to ethnical characteristics of the British Celt according with the indications already suggested by philological evidence; and so to lend some countenance to the idea that the Celtæ intruded on the brachycephalic barrow-builders of Britain, prior to the dawn of history, introduced among them the higher arts of the Aryan races, and themselves underwent the inevitable change consequent on an intermingling of intruding and native races.

The Anglo Saxon is a very modern insular intruder. It is now little more than thirteen centuries since he encroached as a stranger on the home of the native Britons. We may allow the latter an undisturbed occupation for more than double that time, and lengthen the period of their presence in central and north-western Europe, thereby carrying them far back into its prehistoric night; and still ample time will remain for Allophylian precursors. But, so far as the British Islands are concerned, the comparatively recent intrusion of, at least, the Belgæ, probably of the Cantii and Regni, if not also the Durotriges and Damnonii, and even, as some have maintained, of all the tribes to the south of the Brigantes, found in occupation by the first Roman invaders, is more or less clearly indicated. Britain, moreover, had not been so entirely isolated, prior to the era of Roman invasion as to justify any assumption of its undisturbed occupation by a single native race through all previous centuries. To Tacitus, it is obvious no such idea presented itself as the probable theory of British population in the first century, though historical evidence to the contrary was little more available to him than to us.

The revolution recently wrought in the opinions of archæologists and geologists relative to the antiquity of man, renders the idea of

the oldest historical races having been preceded by others, not only one of easy reception, but almost a necessary consequence of the evidence. But leaving altogether out of view the traces of the Drift or Cave-Man, and dwelling exclusively on the cranial evidence derived from regular sepulture, the proofs of physical and ethnical diversity are as striking as those which distinguish living races of very diverse character. When, moreover, the craniologist, already familiar with the cranial type of the later pagan barrows, proceeds to determine that of the British Celt of any period subsequent to the Saxon invasion, he is compelled to classify it apart from the brachycephalic type of the Anglo-Roman period. I can scarcely conceive of this being disputed by any experienced observer; whatever inferences may be derived from the fact. It may be (1.) that the brachycephalic skull of the barrows is not the true Celtic type; or (2.) the difference observable in the modern Celtic head may be consequent on altered diet, habits, on cerebral and intellectual development; or (3.) the modern representative may be no pure Celt, but variously affected by intermixture of Roman, (in its widest sense, *i.e.* not merely Italian, but continental,) Saxon, Norse, Danish, and Norman blood; or (4.), all of those causes may have combined to produce the results in question.

In discussing the physical attributes of the Celtic race, Dr. Prichard asks: "Was there anything peculiar in the conformation of the head in the British and Gaulish races?" and thus replies: "I do not remember that any peculiarity of features has been observed by Roman writers in either Gauls or Britons. There are probably in existence sufficient means for deciding this inquiry in the skulls found in old British cairns or places of sepulture. I have seen about half-a-dozen skulls found in different parts of England, in situations which rendered it highly probable that they belonged to ancient Britons. All these partook of one striking characteristic, viz.: a remarkable narrowness of the forehead compared with the occiput, giving a very small space for the anterior lobes of the brain, and allowing room for a large developement of the posterior lobes. There are some modern English and Welsh heads to be seen of a similar form, but they are not numerous."* But not only did Prichard thus recognise the essential disagreement between the brachycephalic head of the barrows and that of the modern British Celt; but he has also indicated his recog-

**Researches into the Physical History of Mankind:* Third Ed. vol. III.

nition of characteristics in the former, which appear to him other than Celtic. In noticing two well known crania recovered from the Knoch-maraidhe tumulus in the Phœnix Park, Dublin, he remarks: "In these, especially in one of them, there is a considerable approximation to the Turanian skull;" and again in view of those from British cairns and cists, he repeats his belief that some of them give reason to suspect that they had somewhat of the Mongolian or Turanian form of head.*

It seems, at first sight, an undertaking sufficiently compatible with the results already achieved by craniology, to determine the typical form at least of the modern Celtic cranium; but the results have hitherto been of a very indefinite character. One source of error is doubtless traceable to the neglect of the important fact that a type is an ideal abstraction embracing the mean of many variations, and is not to be determined by the selection of one or two assumed characteristic examples. Opinions, however, have been advanced on the authority of experienced observers, in favour of one or more specific forms as that of the true Celtic head. Referring to the small anterior region characteristic of the skulls in ancient British graves, Dr. Prichard remarks: "In this particular, the ancient inhabitants of Britain appear to have differed very considerably from the present."† Mr. Wilde, on the contrary, after referring to two ancient races, whose remains are found in Irish cairns and sepulchral mounds, the one "globular headed," and the other having skulls "chiefly characterised by their extreme length from before backwards, or what is technically termed their antero-posterior diameter, and the flatness of their sides;" adds: "we find similar conditions of head still existing among the modern inhabitants of this country, particularly beyond the Shannon, towards the west, where the dark, or Firbolg race may still be traced, as distinct from the more globular-headed, light-eyed, fair-haired Celtic people who lie to the north-east of that river."‡ Here the Irish archæologist describes two essentially distinct ancient skull-forms, and not only recognises the living representatives of both, but finds the diversity of form accompanied by other distinctions in hair, eyes, and complexion.

Nevertheless it has been generally assumed that one well-defined

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* Researches. vol. iii, p. xx.

† Ibid. vol i. p. 305.

‡ *Lectures on the Ethnology of the Ancient Irish.*

form of head is recognisable as characteristic of the true Celt. Dr. Morton, in defining the Celtic Family, says: "they have the head rather elongated, and the forehead narrow and but slightly arched. The brow is low, straight, and bushy; the eyes and hair are light, the nose and mouth large, and the cheek-bones high. The general contour of the face is angular and the expression harsh."* Dr. J. Aitken Meigs in discussing the characteristics of the race, as represented in the Mortonian Collection, selects a cast bearing the memorandum: "Descendant of an ancient Irish King, Alexander O'Connor, —original in Dublin." Of this he remarks: "No. 1356,—a cast of the skull of one of the ancient Celtic race of Ireland,—appears to me the most typical in the Irish group. This head, the largest in the group, is very long, clumsy and massive in its general appearance. The forehead is low, broad, and ponderous; the occiput heavy and very protuberant. The basis cranii long, broad, and flat; the orbits capacious; and the distance from the root of the nose to the upper alveolus quite short."† Dr. Kombst also, who, during a residence of some years in Scotland, devoted considerable attention to the determination of the Celtic, as distinguished from the Germanic type, states that "the Celtic skull is elongated from front to back, moderate in breadth and length, and the face and upper part of the skull the exact form of an oval."‡ Professor Retzius after studying the modern Celt both in France and Britain, assigns to the cranium of the common race a form of peculiar length, compressed at the sides, narrow and generally low in the forehead. At the same time he ascribes to the true Celtic type of head greater breadth, though still describing the skull as long, oval, and narrow.§ In his latest matured views he groups the Celts as European orthognathic Dolichocephalæ, under the heads: "Scottish Celts, Irish Celts, English Celts, and Welsh;" and when referring to a skull sent to him by Dr. Prichard, as the first Roman one he had seen, he remarks: "It had been picked up on an ancient field of battle near York, with another skull of different form. The latter was smaller, much elongated, straight and low, and had evidently belonged to a Celt."‖ This judgment, he adds, fully

* *Crania Americana.* p. 16.

† *Indigenous Races of the Earth*, p. 301.

‡ *Johnston's Physical Atlas*, c. 8.

§ *Kraniologisches. Muller's Archiv.*, 1849, p. 575.

‖ *Smithsonian Report*, 1859, p. 253.

satisfied Dr. Prichard. But when commenting on the Ugrians, Turks, and Sclaves of Europe, all of whom he includes in his *Orthognathic Brachycephalæ*, Retzius remarks: "On different occasions I have met with brachycephalic Scots from northern Scotland, and the isles to the north. During my last sojourn in Scotland, I encountered again divers individuals pertaining to this same type, having an expression altogether peculiar, their visage being often short and somewhat large, their hair red, the skin of their faces marked with freckles. Since then I have learned from the reports of travellers, that this type is common in the Highlands, where it is indigenous from a remote antiquity. I suppose it has descended from the Finns, or perhaps the Basques." The observations of Professor Retzius are confirmed by those of my friend, Captain Thomas, R.N., whose experienced eye has detected a peculiar type of form and features both in the Orkneys and the Hebrides, equally distinct, as it appears to him from Celt and Scandinavian, which he also conceives to be Finnic. It is well worthy of note, however, that this globular head-form appears to pertain to the Scoto-Scandinavian districts; for, as will be seen, a similar type prevails in the Gallo-Scandinavian district of Normandy; and the same type predominates, according to Mr. Wilde, in the region to the north-east of the Shannon, where in like manner the influence of the Northmen may account for the distinction he defines between them and the long-headed Firbolgs beyond that river. When, however, Dr. Retzius quotes vaguely, "The reports of travellers, that this (the brachycephalic) type is common in the Highlands," the opinion must be received with caution. My own opportunities of observation led me to an opposite conclusion; but from the great difficulty of arriving at any certain results in reference to the relative proportions of the living head, without actual manipulation and measurement, I feel assured that the reports of ordinary travellers on minute distinctions of the kind in question are valueless. It is of a nearly corresponding type that Dr. Prichard remarks: "There are some modern English and Welsh heads to be seen of a similar form, but they are not numerous." But the significance of this globular, or brachycephalic head-form will again come under review in other geographical relations.

Dr. Beddoe, whose observations on the complexion, eyes, and hair of the modern Celt have been already referred to, in a communication to the Society of Antiquaries of Scotland on the ancient and modern

ethnography of the country, states that his deductions relative to the physical characteristics of the Scottish population are based on observations made upon about 20,000 individuals. The complexional character chiefly attracted his attention; but other features were not overlooked. Of the people of Upper Argyleshire and Invernesshire he remarks: "The men have the bony frames, the high cheek bones, prominent brows, and long noses, aquiline, sinuous, or curved upwards towards the point, which I have observed in almost all the more Celtic districts of Scotland;" and he thus indicates the idea he has formed of the Celtic head-form, when referring to the fisher-folk of Buckhaven, St. Monance, Newhaven, and Fisherow: "The narrowness of the crania and faces in many of the women tells against their Teutonic origin, and the family names of the Newhaven and Fisherow folk are just those of the neighbouring counties; some of them indeed, as Caird and Gilchrist, are Gaelic."*

The zeal with which anthropological researches are pursued by the savants of Paris, renders their opinion on this department of ethnical classification, in which they have so peculiar an interest, of the highest value. Unfortunately my access to their published results is greatly more limited than I could desire, though perhaps sufficient for the purpose now in view. M. J. J. D'Omalius D'Halloy, remarks in his *Des Races Humaines*, "It is difficult in the present state of the science to express any positive opinion as to the true characteristics and the actual development of the Celtic Family;" and after referring to the wide area occupied by it in ancient times, and its later intermixture everywhere with encroaching races of conquerors, he adds: "It is probable that the peoples who still speak the Celtic languages are not the pure descendants of the ancient Celts, but that they have resulted from an admixture with the Arameans whom we suppose to have been their precursors in Central Europe, and with the Latins and Teutons, who intruded subsequently. Moreover their characteristics are not uniform; and whilst, for example, the Bas-Bretons have in general their hair and their eyes black, and the stature of the inhabitants of the south west of France, we frequently meet with blond complexions among the Gauls."† Among the scientific anthropologists of Paris, however, the same idea, already referred to, of the elongated skull being the true Celtic type, appears to maintain its

* *Proceedings of Soc. Antiq. of Scotland*, Vol. I. pp. 254, 256.

† *Des Races Humaines, ou Eléments d'Ethnographie*, p. 37.

ground. M. Paul Broca, the learned Secretary of the *Société d'Anthropologie de Paris,* in an ethnological resume addressed to the society in 1863, when contrasting two distinct types of skull—the one brachycephalic and the other dolichocephalic,—recovered from sepulchres of the Burgundian period, affirms of the successive occupants of French soil: "The Celts, the Cymri, and the Germans, were dolichocephali; and so were the Romans in a less degree. There is therefore," he adds, "no question that the brachycephalic type still so prevalent among us, is derived from populations prior to the arrival of the Celts." Again, M. Pruner-Bey, in discussing before the same body the ethnical affinities of the Neanderthal man, characterised by a skull little less remarkable for its great length and narrowness, than for the extreme development of the superciliary ridges, says: "let us try if it is possible to classify the Neanderthal skull. Is it the representative of a lost race, or can it be identified with any of the stocks which are known to us? In my opinion it is undoubtedly the skull of a Celt; it belongs to a large individual; it is capacious and dolichocephalic; it presents the depression on the posterior third of the sagittal suture common to the Celts and Scandinavians; and finally its occipital projection is equally characteristic of these two races." M. Pruner-Bey then produces one Helvetian and two Irish skulls as illustrations of the true Celtic type, and thus proceeds: "Whilst they all present the same general type, these three skulls exhibit slight differences. There even exists a fourth variety, represented in the collection of Retzius by an ancient Belgian, whose skull is more compressed laterally than that of the first Irishman, which is almost cylindrical. In the gallery of the museum there is a sufficiently numerous series of ancient French skulls of the same type in every respect as those before us. . . . Without entering into descriptive details respecting the ancient Celtic skull, you will recognise that all the ancient skulls before us present a very depressed forehead, compared with the enormous facial development; but that which the forehead loses in height it gains in length." He then, in considering the evidence that the skulls produced are really Celtic, refers, among other proofs, to "comparison by the retrogressive or progressive method with skulls of Bretons, French, and modern Irishmen, in which the mass are undoubtedly Celtic;" and adds: "Although the Celtic skull has undergone some secondary modifications, its type is at the present day the same as in the most remote ages. I refer to

the beautiful series of modern skulls in the museum, derived from Brittany, and to my own collection of modern Irish skulls." In a letter on the same subject, addressed by M. Pruner-Bey to Mr. C. C. Blake, of the London Anthropological Society, he refers to "the elliptic form (segmental) of the occiput as well as of the coronal as truly characterising the Celtic type."* The crania selected by him as typical Celtic skulls, measure, in centimetres, longitudinally and parietally as follows:

Helvetian, length,	19.5;	breadth,	14.5.
Irish No. 1, "	20.0;	"	15.0.
Irish No. 2, "	20.5;	"	14.3.

The discussions originating in M. Pruner-Bey's observations on what he finally designates "The long-headed Celt of Neanderthal:" though they elicited opinions at variance with his ethnical classification of the remarkable skull discovered in 1837 in the Neanderthal cave; have not, so far as I am aware, led to any challenge of the typical form thus asserted for the Celtic skull of France, as well as of Switzerland and Ireland.

It accordingly appears thus far, from the various authorities referred to, that considerable unanimity prevails in the ascription of an excess of longitudinal diameter as one of the most marked characteristics of the Celtic cranium. A long but low frontal development, in which, as M. Pruner-Bey defines it, "The forehead of the ancient Celt gains in length what it loses in height;" a flattening of the parietals, and a tendency towards occipital prolongation, are all more or less strongly asserted as characteristic of the same head-form. There are marked exceptions, however, to this apparent unanimity. Professor Nillson —who, in his earlier definitions, had spoken of the Celtic cranium as intermediate in proportions to the true dolichocephalic and brachycephalic skull-forms,—when writing more recently to Dr Thurnam, remarks in reference to that cranium: "I consider nothing more uncertain and vague than this denomination; for hardly two authors have the same opinion in the matter. It would indeed be very desirable if, in England, where it might most conveniently be done, one could come to a proper understanding as to what constitutes the Celtic form of cranium, and afterwards impressions in plaster-of-paris be taken of such a cranium as might serve as a type for this race."† The de-

* *Anthropological Review.* Vol. II. p. 146.

†*Crania Britannica*, Dec. i., p. 17.

mand of the Swedish naturalist is more desirable than easy of accomplishment. What tribunal is to determine the coveted cranium embodying in itself the ideal type? Dr. Spurzheim directed a series of minute observations with this object in view; and other evidence shows that the body of British cranioscopists called into being by the teachings of Dr. Gall and his collaborateurs, systematically aimed at determining this and other leading ethnical types. The collection of the Edinburgh Phrenological Society includes a cast marked as the Celtic type: one of a series described in the Phrenological Journal as "selected from a number of the same tribe or nation, so as to present as nearly as possible, a type of the whole in the Society's collection."* It is characterised in the catalogue as a "long Celtic skull;" and as will be seen from its measurements,—No. 16, in the following table of crania, otherwise obtained from ancient Celtic areas under circumstances that afford the greatest presumptive evidence of their truly representing the native race,—it is remarkable for its length and narrowness. It is also characterised by the narrow, elongated frontal region, which French anthropologists appear to recognise as a typical Celtic feature.

An unbiassed judgment, as well as great sagacity and experience, is required to determine such a selection in comparative craniology. Wilde, as we have seen, describes the heads of the Irish beyond the Shannon as distinct from what he calls "the more globular headed, light-eyed, fair-haired Celtic people" to the north of the same river. The former, with long heads, he designates the dark or Firbolg race, the representatives as he conceives of the aboriginal Irish Cromlech-builders. But who the Firbolgs were, and whence their name is derived, are questions still in dispute among Irish antiquaries and historians. They came into Ireland according to the *Annals of the Four Masters*, A.M., 3266. O'Flaherty, in his *Ogygia*, fixes their advent at the still earlier date of A.M., 2657. Keating, Algernon Herbert, and others believe them to have been a colony of Belgæ, or other Gaulish tribe; and the last named authority regards the date of their arrival in any part of the British Isles as little more than a century before Christ.† On this latter theory, it is in no degree remarkable that a comparison of Breton, French, and Irish skulls in Parisian collections, should produce such harmonious results. But Dr. Davis,

* Phrenological Journal. Vol. VI. p. 144.

†*Irish Nenius*, pp. 44, xcix.

who assumes the short crania of the barrows to represent "the typical form of cranium of the ancient Britons," describes them as "somewhat short or brachycephalic, not ill-developed, nor remarkable for a small facial angle. The bones of the face, and especially the upper maxillaries, upright or orthognathous, but also rather short. The chin is usually prominent, the exterior surface of the upper maxillaries depressed, the nose abrupt and short, surmounted with a frowning eminence, marking the situation of the frontal sinuses."* Having thus determined the typical Celtic head-form, Dr. Davis disposes of the remarkable class of extreme dolichocephalic crania already referred to as found in Britain, by classing them, along with other variations from his Celtic type, as: "aberrant forms." Here therefore we see to how great an extent the selection of any assumed typical form is liable to be affected by preconceived theories.

But another difficulty meets us when we attempt to select the living representative of the pure Celt. M. D'Halloy classes the French, apart from the Celtic family, under *La Famille Latine*, but he adds: "It is probable that the French derive their origin principally from the Celts; but these submitted during five centuries to the Romans, and not only mingled with them, but have entirely lost the use of the Celtic languages. Subsequent conquests, repeatedly effected by Teutonic people, subjected them to fresh admixture, and they took the name of French; but the descendants of the conquerors lost the use of the Teutonic languages, and the Latin dialects have prevailed. . . It is probable that the people of Central France are those who remain most thoroughly Celtic; that those of the south have inherited the vivacity of the Basques; and that those of the north have undergone more change from Teutonic races. This influence has been chiefly felt in Normandy, which received its name in consequence of its settlement by Scandinavians in the tenth century."† Turning from France to Britain, the same difficulties are encountered; and even when we confine ourselves to what are commonly designated the purely Celtic districts of Wales, Scotland, and Ireland: the northern and western Highlanders of Scotland differ little less noticeably than the Irish on either side of the Shannon, while the Welsh are distinguishable in many respects from both. In Sir David Wilkie's graphic picture of the "Reading of the Waterloo Gazette," the characteristic

* On the Crania of the ancient Britons. *Proceed. Acad. Nat. Sc. Philadelphia.* Feb. 1857, p. 42.

† *Des Races Humaines*, pp. 38, 40.

differences between the English dragoon, the Highland sergeant, and the Irish private, are as obvious as the distinctive features of the Negro who mingles in the same jovial group. M. D'Halloy excludes the region of Brittany from the France assigned by him to its branch of the Latin Family. But even the retention of the Celtic language is no certain test of purity of race; and it is more easy to imagine, than to estimate by any definite scale, the influence which Roman, Frank, Burgundian, Saxon, Dane, Norman, and other foreign blood, have exercised in effecting the diversities referred to. Taking, however, crania derived from Highland districts where the Gælic language still prevails, and from cemeteries of the earliest Columbian and Pictish Christian foundations, we have some reason to anticipate in them an approximation to the true form of the Celtic head subsequent to the Roman invasion. The following table embraces such a selection, illustrating the character of the native population in different parts of the British Islands, at a period when the first Celtic missionaries of Scotland and Ireland were preaching to their converts in their native tongue.* The measurements are *Longitudinal diameter, Frontal breadth, Parietal breadth*, and *Horizontal circumference*.

BRITISH CELTIC CRANIA.

	Locality.		L. D.	F. B.	P. B.	H. C.
1	Iona	M	7.3	4.5	5 5	20.2
2	"	M	7.2	4.7	5.5	20.6
3	"	M	7.4	5.0	5.6	20.9
4	"	M	7 1	4 5	5.6	20.0
5	"	M?	7.3	4.6	5.7	19.9
6	"	M	7.3	4.3	5 4	20.7
7	St. Andrews	M	6.8	4.8	5.5	20.4
8	"	M	7.0	4.4	5 3	20.3
9	"	M	7.3	5.0	5 8	21.5
10	"	F	7 2	4.4	5 0	20.2
11	Kintyre	M	7.7	4.8	5 0	21.2
12	Larnahinden	M	7.5	4 6	5 1	20.2
13	Caithness	M	7.7	4.3	5.5	20.9
14	Northampton	M	7.5	4 4	5.4	20.6
15	Longford	M	7.8	5.1	5.6	21.9
16	Celtic Type, E. P. M.		7.9	4.8	5.4	21.5
	Mean		7.37	4.64	5.43	20.69

* For additional measurements, and the circumstances of discovery justifying their Celtic classification, vide *Prehist. Annals of Scotland*, 2nd edit., vol. I., p. 284.

In so far as a comparison can be instituted between this group of Crania and those previously referred to, it will be seen that the latter are smaller than the examples of the Helvetian and Irish Celtic head. Nevertheless they agree with all other evidence in confirming the predominance of a head of unusual length, in more than one of the ancient insular races. But a comparison of the results of the above table, in longitudinal and parietal measurements, with the Kumbecephalic and Brachycephalic crania of British megalithic tombs and barrows, as derived from the mean results of examples of each class, is of more importance, from the remarkable amount of diversity it reveals among the ancient insular races.* For the purpose of comparing them with the typical Celtic crania of M. Broca, previously referred to, the measurements are given both in inches and in centimetres.

Kumbecephalic crania,	length,	7.44, or 18.897;	breadth,	5.27, or 13.385
Brachycephalic "	"	7.12, " 18.084;	"	5.70, " 14.477
Celtic "	"	7.37, " 18.719;	"	5.43, " 13.792

I shall now turn to another test, to which I have already repeatedly referred in former papers, as calculated to furnish useful comparative craniological data. The hatter in the daily experience of his business transactions, necessarily tests the prevalent form and proportions of the human head, especially in its relative length, breadth, and horizontal circumference; and where two or more distinct types abound in his locality, he cannot fail to become cognisant of the fact. One extensive hat manufacturer in Edinburgh, states that "the Scottish head is decidedly longer, but not so high as the English. In comparison with it the German head appears almost round." But comparing his scale of sizes most in demand, with others furnished to me from Messrs. Christie, the largest hat makers in England, the results indicate the prevalent Scottish size to be 22$\frac{5}{8}$ inches; four of this being required for every two of the next larger and smaller sizes; whereas in assorting three dozen for the English trade, Messrs. Christie furnish four of 21$\frac{1}{2}$, nine of 21$\frac{3}{4}$, ten of 22, and eight of 22$\frac{3}{8}$ inches. Mr. Rogers, of Toronto, in assorting three dozen, distributes them in the ratio of five, seven, nine, and five to the same predominant sizes, and allows four for the head of 23 inches in circumference, the remainder being in both cases, distributed in ones and two between the largest and smallest sizes, ranging from 23$\frac{3}{4}$ to 20$\frac{3}{4}$ inches.

*Vide Ibid, Tables I., II., vol. I., pp. 267, 275.

The summary of inquiries among the principal hatters of Boston is as follows: "Larger hats are required for New England than for the Southern States. To New Orleans we send $20\frac{5}{8}$ to $22\frac{7}{8}$; and to New Hampshire $21\frac{3}{8}$ to 23 inches." One extensive New England manufacturer adds: "New England heads are long and high; longer and higher than any European heads. British heads are longer than Continental. German and Italian heads are round. Spanish and Italian very small."

Let us now see if this experience acquired in the daily observation of the trader and manufacturer will yield any available results in reference to our present inquiries. An ingenious instrument, known by the name of the *Conformiteur*, was brought into use in Paris, I believe about twenty years since, and is now employed by many hatters, on both sides of the Atlantic, for the purpose of determining the form and relative proportions of the human head, so far as required by them. The instrument fits on the head like a hat; and, by the action of a series of levers encircling it, repeats on a reduced scale, the form which they assume under its pressure. By inserting a piece of paper or thin card board, and touching a spring, the reduced copy is secured by the impress of pins attached to the ends of the levers. Owing to this repetition being made on the top by limbs of equal length, acting, within a circle, at right angles to the main levers, the form produced is more or less exaggerated longitudinally in proportion to the length of the head. But this does not interfere with the value of comparative results derived from numerous head–forms taken by the same instrument, and correspondingly affected according to their relative proportions.

Taking advantage of the precise data furnished by the *conformiteur*, I have availed myself of the peculiar facilities which Canada supplies for instituting a comparison between the diverse races composing its population. Upper Canada is settled by colonists from all parts of the British Islands. In some districts Highland, Irish, German, and "Coloured" settlements perpetuate distinct ethnical peculiarities, and preserve to some extent, the habits, and usages, and even the languages of their original homes. But throughout the more densely settled districts and in most of the towns,* the population presents much the same character as that of the larger towns of England or Scotland,

* The exceptions in the Upper Province are where a large coloured population has congregated; as at St. Catharines, Chatham, and Windsor.

and the surnames form in most cases the only guide to their ethnical classification. In Lower Canada the great mass of the population is of French origin, but derived from different departments of the parent country; of which Quebec is the centre of a migration from Normandy while the district around Montreal was chiefly settled by colonists from Brittany. The French language, laws, religion, and customs prevail, preserving many traits of the mother country and its population, as they existed remote from the capital of the Grande Monarque, and before the first French Revolution. The establishment of the seat of the Provincial Government at different times in Montreal and Quebec, and the facilities of intercourse between the two cities, must have helped to mingle the Norman and Breton population in both. Nevertheless, the results of my investigations tend to show that a striking difference is still recognisable in the predominant French head-forms of the two cities.

My first observations, with special reference to the present inquiry, were made at Quebec, in 1863, when, in co-operation with my friend Mr. John Langton, I tested the action of the conformiteur on heads of various forms, and had an opportunity of examining and comparing nearly four hundred head-patterns of the French and English population.* As each of the patterns had the name of the original written upon it, a ready clue was thereby furnished for determining their nationality. Since then, in following out the observations thus instituted, I have carefully examined and classified eleven hundred and four head-shapes; including those of two of the principal hatters in Montreal, and of one in Toronto.† In testing their various differentiæ, I have arranged them by correspondence in form; by common origin, as indicated by French, English, Welsh, Highland, Irish, and foreign names; and by predominant malformations in those markedly unsymmetrical. The first noticeable fact in comparing the head-forms of the Quebec population was that they were divisible into two very dissimilar types: a long ovoid, and a short, nearly cylindrical one: This is so obvious as to strike the eye at a glance. I accordingly arranged the whole into two groups, determined solely by their forms, without reference to the names; and on applying the latter as a test, the result showed that they had been very nearly classified into French

* Mr. J. Ashworth, Qnebec.

† Messrs. J. Henderson & Co., and A. Brahadi, Montreal; and Mr. J. Rogers, Toronto.

and English. In all, out of nearly a hundred head-forms marked with French names, only nine were not of the short, nearly round form ; and no single example of this short type occurred in one hundred and forty-seven head-forms bearing English names. A more recent examination of patterns from Montreal led to a very different result. There, where out of the first fifty English head-forms I examined, one example of the short globular type occurred; out of seventy French head-forms (classified by names,) only eleven presented the most prevalent French head-type of Quebec. But the French head of the Montreal district, though long, is not the same as the English type. It is shorter, and wider at the parietal protuberances ; and with a greater comparative frontal breadth, than what appears to be the Celtic sub-type of the English head : though also including some long heads of the latter form. So far, therefore, it would seem a legitimate inference from the evidence, that the brachycephalic and nearly globular head of the Quebec district is the Franco-Norman type ; while the longer French head of the Montreal district is that of Brittany, where the Celtic element predominates.

But again, amid considerable diversity in minute characteristics, the English heads appear to be divisible into two classes, of which one, characterised by great length, and slight excess of breadth in the parietal as compared with the frontal region, appears to be the Anglo-Saxon head ; the other, also long, but marked by a sudden tapering in front of the parietal protuberances, and a narrow prolonged frontal region, is the insular Celtic type. These inferences I deduce from the following data. A certain number of the head-forms, marked by the extreme characteristics of great length and nearly uniform breadth, all bear true English or Saxon names, *e. g.* : Anderson, Bell, Booth, Brown, Beard, Blackie, Cosford, Chapman, Dean, Forster, Fisher, Guest, Giles, Mason, Steel, Sanderson, Thompson, Westby, Waddel, &c. Out of upwards of four hundred heads more or less nearly approximating to this type, only two presented the exceptional names : O'Callaghan and Donovan. The form which I distinguish from this as the British Celtic type, is equally long, but otherwise very different, approaching to what may be most fitly designated the pear-shape. Of this I have found representatives of all the insular subdivisions of the Celtic race, *e. g.* : Campbell, Fraser, Grant, McLean, McKenzie, McDonald, McMillan, McLeay, McKay, McLennan McGregor, Stuart, &c. ; Beaven, Davis, Evans, Flynn, Hughes, Jones, Owen,

Gwynne, &c.; and Donelly, Flaherty, Flannigan, Kelly, Macguire, McCaul, McLeary, McCollum, O'Brien, O'Calahan, O'Reilly, &c. The subdivisions which such names suggest are scarcely less obvious than those which, in Lower Canada, separate the Browns, Smiths, Hendersons. Thompsons, Masons, Langtons, Fenwicks, Frisbys, &c., from Charlebois, Barbeau, Charpentier, Chartraud, Deslauner, De-Lusingnan, Durocher, Filialreaut, Labelle, Lafontaine, Lemieux, Montigny, Nadeau, Perrault, Robitail, Simard, Saudier, Verrier, &c.

But the Saxon and Celtic names of the British Islands indicate races which have been intermingling for centuries, until many lines of demarcation have been nearly effaced; whereas the French and English populations of Lower Canada are still separated by the clearly defined traces of recent contact. The latter condition of things is illustrated in their head-forms. With few exceptions they can be distinguished from each other at a glance. Whereas, although the two types which I conceive to be the Saxon and Celtic head-forms of the British Islands, are satisfactorily classed apart, by such evidence as I have indicated: yet many modified forms occur, disclosing all intermediate gradations between the two; and occasionally the pure Saxon type bears a Celtic name, or *vice versâ*. Normandy did indeed once furnish its quota of colonists to Britain as well as to Lower Canada. But, if the followers of William of Normandy included those of the brachycephalic type now met with in Canada, they have long since intermingled with, and been absorbed into the common mass. Exceptional forms are traceable at times, where the evidence is accessible, to the miscellaneous sources of intrusive population. One head of peculiar and marked brachycephalic form, with a common English name attached to it, proved to inherit its specialities from a Hindoo mother; another, no less striking for its peculiar length, was that of a "black Douglas." In these cases the names were calculated to mislead; but in general they furnished the desired clue. In arranging a large collection of head-forms according to their shapes, I found on one occasion that I had thrown sundry exceptional patterns aside as failing to classify under any of the determinate types of French and English heads. On returning to examine the names, they read as follows: Kleisen, Lansberg, Rosebrugh, Snider, Kauffman, Kendrick, DeWintol, Bastedo, Hirsch, Levy, Benjamin. The list of names abundantly accounts for the miscellaneous character of their head-forms, if there is any ethnical foundation for such a system of classification.

So far then as this evidence indicates, the French head as found in the Montreal district, with its Breton population, presents a longer type than that of the Quebec district with its colonists from Normandy. This therefore seems to point to the assignment of the longer head to the more Celtic French race. Again, the Celtic head-form of the British Islands appears to be still more dolichocephalic; and so constant is this, that out of ninety-three head-forms bearing Celtic names, I have only met with six approximating to the short or brachycephalic type; and out of five hundred and forty-two with Anglo-Saxon names, only thirteen of short type; and this among a population inter-marrying with their fellow-subjects of French origin, and with no permanent barrier to the ultimate blending of the two races into one. So far as the cranial evidence defines a difference between the two types of head of the French habitans, it accords with the historical data referred to by M. D'Halloy in his *Races Humaines*, where—after referring to the predominance of Teutonic influence on the population of Northern France classed by him in the LATIN FAMILY, as distinct from the Bas-Bretons and others of the CELTIC FAMILY, he adds: "Cette influence se fait surtout sentir en Normandie, contrée qui doit son nom aux établissements que des Scandinaves y ont formés dans le 10e siècle." The population was distinguished by language as well as name from the Celtic north-west of Neustria, long before the invasion of the Northmen. Romanised Gauls, Franks, and Burgundians were mingled under Merovingian, Carlovingian, and Scandinavian conquerors, by processes very analogous to those which made Celtic Britain Anglo-Saxon. Nor is the character of the Franco-Canadian wholly inconsistent with the idea of a temperament modified by some infusion of Norse or Danish with the older Gaulish and Frankish blood. Instead of what Tennyson calls "the blind hysterics of the Celt," the Canadian Habitant is marked by a docile and kindly temperament, which presents some analogies to that of the Scoto-Scandinavian population of the Orkneys. Sheriff Robertson, of Orkney, after long experience in the exercise of his judicial functions there, illustrated the character of the population by referring me to one of the Islands forming a distinct parish with several hundred inhabitants, who dwelt there without resident justice, magistrate, or constable, and had never given him occasion to bring his judicial services into requisition. This he contrasted with the more irascible fervour of the Celtic population on the neighbouring Scottish mainland. But if the brachycephalic head of the Quebec

district is not Celtic, it is not Scandinavian; but rather belongs to the round and short form of cranium, which constitutes one of two marked types, recovered by M. Brullé, of Dijon, from what he believes to be sepulchres of the time of the Burgundians. Specimens of those, and others of the same type, are in the Parisian Society's Gallery; but they appear to be universally assigned there to a pre-Celtic race.

Here again we see the influence of preconceived ideas. The Finnic hypothesis of Arndt and Rask lies at the foundation of the opinions advanced by Prichard, Retzius, D'Abbadie, Pruner-Bey, Broca, Thomas, and others, as to the Finnic type of the Basques, and the pre-Celtic head-form of Denmark, France, England and Scotland. This assumes the Finnic physical type to survive from periods long anterior to the arrival of Celts or other earliest historic races in Europe. But it is possible that we are tempted by the present tendencies of anthropological research, in its alliance with geology, to slight recent for more remote sources. That the Scandinavian nations shared with a Finnic population, their common country, is as certain as that the Franks intermingled with the Gauls, and the Angles and Saxons with the Britons. It can scarcely be doubted, moreover, that the Finns—occupants of a diminishing area within all recent centuries,—formed a larger proportion of the population of Northern Europe in the ninth century than they do now. In that century it was that the Norwegians and Danes commenced their inroads on the British Islands, North Holland, and Normandy; and that Norskmen, Danskermen, and Ostmen, Fion-ghaill and Dubh-ghaill, began to effect settlements in those countries where their traces still abound. But the Finns, who are elsewhere a hypothetical element of the population of prehistoric Europe, occupied the isolated Scandinavian peninsula in common with the Northmen; and are even now to be met with on Norwegian fiords from whence the marauding Vikings were wont to issue forth. Subsequent, however, to A.D. 1000,—the era of St. Olaf,—increasing intercourse with other nations has tended to approximate the Scandinavian to the Germanic type. Seeing, then, the independent concurrence of so much evidence in proof of the predominance of a brachycephalic head-form, approximating to the assumed Finnic type, in the very regions of Orkney and the Scoto-Scandinavian mainland, in the north-east of Ireland, and in Normandy, where Norse influence most abounded: is it logical to ignore this, and seek the source of such ethnical peculiarities wholly among hypothetical precursors of the

historic races? Wherever a native population holds its ground as a race in the midst of its conquerors, intermixture in common interests, and in blood, is inevitable. Gaul joined with Frank in the struggle against Rollo and his Northmen: Gael and Saxon fought together for Scottish independence, against the Edwards; Welsh and English shared with the Norman the triumphs of the Black Prince; as the modern Hindoo, Affghan, Red Indian, and Negro, have been enlisted in the service of their Anglo-Saxon masters. The discrepancy of races in most of those instances surpasses that which results from the assumption that the wild hordes of Norse marauders included Finns as well as true Scandinavians. Their intermixture, in recent centuries is no mere assumption; but a well established fact.

The Northman of the ninth century was by the nature of his geographical position more Finnic than the Dane. The Norwegian and Swede are so even at the present day. I have carefully examined a series of Scandinavian and Finnic crania in the collection of the Academy of Sciences of Philadelphia, with a view to this question. The true Norwegian and Swedish head is dolichocephalic, of moderate length and frontal elevation; but the "Swedish Finn," or mixed race,—of which the collection includes three examples,—is short and semi-globular, partaking of the characteristics of the true Finn, with its marked parietal, and short longitudinal development. The Philadelphia collection contains nine pure Finn skulls and a cast, in addition to those of the Scandinavian and mixed races, nearly all selected by Professor Retzius, and highly illustrative of the two distinct types, and the intermediate hybrid form. It seems, therefore, in no degree inconsistent either with scientific or historical evidence, that we should trace a historic, as well as a prehistoric Finnic element in the brachycephalic and semi-globular head-forms of Orkney, the Hebrides, the north-east of Ireland, Normandy, and the Quebec district of Lower Canada. But on any supposition we must not overlook the characteristics of the races with whom the intruders intermingled. Among the Scandinavian crania of the Mortonian collection, are three ancient Swedish skulls of extreme dolichocephalic proportions, which would probably be classed as Celtic by those who regard the elongated cranium as the unvarying characteristic of the latter type, and maintain the preoccupation of Scandinavia by a Celtic race. To assume that the Franco-Roman population of Neustria prior to the Norman invasion was purely Gaulish, would be to ignore all history from Julius Cæsar

to Charlemagne. "All the foreign peoples of the Indo-European stock," says M. Broca, when referring to the intermixture of races on the French soil, "who have, one after another, invaded, conquered, or occupied the whole, or a part of our country, the Celts, the Cymri, the Germans, were dolichocephalic, and so were the Romans, though in a less degree. It is, therefore, not doubtful that the brachycephalic type still so prevalent among us, is derived from populations anterior to the arrival of the Celts."

Taking then the known elements as our guide: if all but the Celtic form can be determined, there can be no insurmountable difficulty in ascertaining its type. Assuming the modern German head as a key to the influences of Frank and other Germanic intermixture, it is decidedly shorter and more globular than the Anglo-Saxon head. Indeed my attention was first directed to the hat-gauge as a useful cranial test by a remark of the late Dr. Gustaff Kombst, that he could never procure an English-made hat that would fit his head, owing to the greater length and narrowness of the English head. Leaving out of consideration, then, for the present, any race prior to the Gauls: it is wholly consistent with historical evidence to conceive of them, modified by successive interfusions of trans-Rhenic and other Roman legionaries, the later Franks, and others of Germanic blood; and then of Danes and Northmen, with whatever amount of Finnic element the latter may have been affected. Still the type of head characteristic of the population of Normandy, and of Lower Canada at the present day, requires, either that the undetermined Celtic element modified by all those dolichocephalic foreign influences, must have been brachycephalic; or, that, altogether prior to the first Roman invasion, there existed there a large predominance of such a pre-Celtic element as the Finnic one, assumed as unquestionable by M. Paul Broca, and other French ethnologists. For no permissible augmentation of a Scandinavian-Finnic element would suffice to account for the modern head-form, on the theory of an extreme dolichocephalic Gaulish cranium. Against the conclusion that the Gaulish head resembled the brachycephalic type of the British barrows assigned by Dr. J. B. Davis to the British Celts, two arguments are of considerable weight. (1.) The modern Normandy-head, though brachycephalic, has more affinity with the semi-globular type of the mixed Swedish-Finn, than with that of the British barrows. (2.) The Breton head, in which it cannot be doubted that the Celtic element predominates to a much greater extent than in

that of Normandy, instead of approximating more closely to the British brachycephalic type, confirms the idea of a dolichocephalic Celtic head-form. But the analogy of the modern Germanic head, with its numerous sub-types, suggests the probability, that the once widely diffused Celtic nations included variations in physical form, no less definite than those which distinguish the Cymric from the Gaelic subdivisions of their language. The Gaulish and British head-forms must be assumed to have belonged to a common type; but it is probable, if not indeed demonstrable, that they included varieties not less distinct than those of the modern German and Anglo-Saxon. The inquiry, however, is just at that stage when the careful setting forth of the whole evidence—even where it may seem to conflict,—is best calculated to lead to a satisfactory decision. The known, unknown, and undetermined elements of the proposition may, I think, be fairly stated as follows: leaving the Celtic element to be determined by comparison between the modern head-form as the sum of the whole, and the value of the ascertained elements. Thus tested, the weight of evidence appears to be in favor of the Dolichocephalic as the undetermined, and therefore the Celtic element:—

BRETON HEAD-FORM.

Pre-Celtic, Turanian or Finnic element	*Brachycephalic?*
Frank and other Germanic elements	*Dolichocephalic.*
Native Celtic element	——— ?

Modern Head:—DOLICHOCEPHALIC.

NORMANDY HEAD-FORM.

Pre-Celtic elements	*Brachycephalic?*
Germanic elements	*Dolichocephalic.*
Scandinavian: Norse element	*Dolichocephalic.*
" Finnic element	*Brachycephalic.*
Native Gaulish element	——— ?

Modern Head:—BRACHYCEPHALIC.

ENGLISH HEAD-FORM.

Pre-Celtic element: Megalithic race	Kumbecephalic.
Pre-Celtic (?) element: Barrow race	Brachycephalic.
Germanic elements: Anglian, Saxon, Frisian	Dolichocephalic.
Scandinavian elements: Danish, Norman	Dolichocephalic.
Native British element	——— ?

Modern Head:—DOLICHOCEPHALIC.

SCOTTISH HEAD-FORM.

Pre-Celtic element: Megalithic race	Kumbecephalic.
Pre-Celtic (?) element: Barrow race	Brachycephalic.

Germanic elements: Anglian	Dolichocephalic.
Scandinavian elements: Norse, Danish	Dolichocephalic.
Celtic elements: Gaelic, Erse, British	———— ?

Modern Head-Form: DOLICHOCEPHALIC.

The results of comparisons instituted from time to time between English and Scottish heads, and confirmed by the practical experience of hatters in both countries, lead me to the belief that they differ in the greater length and less height of the Scottish than the English head. Leaving out of question the pre-Celtic elements in both cases, the others can be defined with tolerable precision. The traces of the Briton in Scotland are as unmistakeable as those of the Gael in Wales. Nevertheless the British is the predominant Celtic element in the South, and the Gaelic in the North. Of the Germanic elements the Saxon is exclusively English; the Anglian, and apparently the Frisian, Scottish. Of the Scandinavian elements, the Danish predominates in England, the Norwegian in Scotland; and the latter was very slightly affected by any Norman element. It is also important to bear in remembrance the relations in which the races stood to each other in the two countries. In England the remnant of Romanised Britons rapidly disappeared before the Saxon and Anglish colonists; so that when the Danes followed in their wake, they found only an Anglo-Saxon people to resist or to intermingle with. In Scotland, on the contrary, a race of Celtic kings occupied the throne of the united kingdom till the death of Alexander III. in 1286. There also the Northmen of the Islands and Sutherland intermingled with a purely Celtic population. In the war of independence the Islesman and the Highlander of the mainland made common cause with the lowland Scot; and the Gaelic and Anglo-Scandinavian races intermingled on perfect political equality: the Gael only exchanging the Celtic for the English tongue, when he passed beyond the Highland line, and merged into the mixed stock of the low country.

It thus appears that where the Celtic element most predominates, the longer form of head is found. It is also noticeable that there are indications of the Gaelic and Erse type of head being longer than the British. The results, as a whole, of the classification of the known and unknown elements in tabular form, appear to involve the assignment of dolichocephalic characteristics to the undetermined Celtic element both of the French and English head.

The question invites further research, in all its bearings; and as one

subsidiary source of information, the population of Lower Canada furnishes materials valuable alike to the ethnologist and the historian. There a people of French origin has been isolated from the great revolutions which have wrought such changes on their European congeners. Their physical, moral and intellectual development, all admit of curious comparison with those of the modern Frenchman. The first has been subjected to novel climatic influences for upwards of two centuries; the latter have been moulded by political and religious institutions, brought with them from their old home by the colonists of Louis XIII.; whose descendants have only recently emancipated themselves from seignorial tenures and other shackles of a feudal system of centralization. Those, with the habits of life incident to a climate so diverse from that of northern France, may account for some characteristic traits. Others may be still found among the kindred population of Normandy or Brittany. But, assuredly the summary way in which Dr. Knox has dealt with this element of the European population of the New World, as "The French Celts of the Regency," is wholly unworthy of acceptance.*

Apart, however, from all theory or inductive reasoning, the following facts appear to be indicated in reference to the colonists of Lower Canada: 1st. That the French Canadian head-forms are, as a rule, shorter and relatively broader than the British; 2nd. That the former are divisible into two classes, of which the short globular, or brachycephalic head occurs chiefly in the Quebec district, settled from Normandy;† while the longer type of head predominates in the Montreal district, originally colonised by a population chiefly derived from Brittany and the Department of Charente Inferieure. The mode of investigation thus indicated yields certain definite results, and admits of wide application. Should the anthropologists of Paris be induced to turn their attention to it, the means of comparison supplied by a similar determination of the head-forms of regiments composed of conscripts from Bretagne, Normandie, Franche Compté, Languedoc, and Gascoigne, might go far towards eliminating the true Gaulish

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* *Races of Men:* p. 75.

†In the summer of 1863, immediately after examining the Canadian head-forms of the Quebec district, I made a tour through Normandy, and specially directed my attention to the head forms of the peasantry. A short form of head appears to prevail; but without positive measurement no precise results can be attained.

type; and could not fail to supply other information no less acceptable to the ethnologist.

But there is another aspect of the inquiry into the significance of cranial forms which derives striking illustration from the mode of investigation now referred to. When treating in a former communication,* of the various causes tending to produce unsymmetrical cranial development, I remarked: The normal human head may be assumed to present a perfect correspondence in its two hemispheres; but very slight investigation will suffice to convince the observer that few living examples satisfy the requirements of such a theoretical standard. Not only is inequality in the two sides of frequent occurrence, but a perfectly symmetrical head is the exception rather than the rule. The examination of the head-forms already described amply confirms this opinion. Examples of extreme dissimilarity between the two sides, and of abrupt inequalities of various kinds are far from rare. Of one group of 373 head-forms carefully tested for their unsymmetrical characteristics, only 48 could be set apart as uniform, or only slightly unsymmetrical, and not decidedly developed in excess on one side or the other. Of the French heads 67 exhibited a decided development towards the left, with a flattening or depression on the opposite side; and 20 were correspondingly affected towards the right side. Of the British heads, including those with Celtic and other patronymics, 116 exhibited a decided bulging to the left side, and 31 a less decided development in the same direction; while 63 had the same characteristic feature no less strongly on the right side, and 23 a less decided bulging to the right. In all, the results on this point were, that out of eleven hundred and four British and French head-forms, four hundred and forty-two were developed in excess to the left, and three hundred and eighteen to the right; leaving three hundred and forty-four nearly symmetrical. It thus appears that the tendency to unsymmetrical deformity is nearly as three to one; and that in the abnormal head the tendency towards excess of development towards the left, is upwards of two to one. But so far as my opportunities of investigation have extended, this tendency is more decidedly expressed in the brachycephalic (French) heads than in the dolichocephalic, and in those the sinistral is to the dextral excess fully in the ratio of three to one. I

***Ethnical forms and undesigned artificial distortions of the human skull. Canadian Journal,* vol. vii., p. 414.

have discussed the probable causes of such deformations in former papers, and need not resume the subject here.

Another slight, but curious, indication of the unsymmetrical arrangement of the two sides of the head is shown by the position of the ears. To this my attention was drawn by my friend, Mr. Langton, when examining the French head-forms at Quebec. By attaching a paper frame to the rim of a hat, and marking a line corresponding with the centre of each ear, the oblique distortion, which is best observed by looking on the base of the skull, is readily detected in the living head. The extent to which the ears diverge from the opposite points of a line drawn at right angles to the longitudinal diameter is frequently startling to those whose attention is directed to it for the first time. No ethnical significance can be attached to such irregularities in cranial conformation. The same, I doubt not, will be found among all races; and the habits of civilized nations tend no less to their production, than the undesigned usages of savage tribes. One of the most remarkable examples of an unsymmetrical skull which has recently come under my notice, is that of a Chinese, in the collection of Dr. Warren, at Boston, which is distorted obliquely, with predominant development on the left side.

One other question, which may receive illustration from a sufficiently extensive series of observations, is that already referred to, of the possible changes of head-form by mere lapse of time, with the accompanying modifications of diet, climate, and habits of life. Among the short head-forms occurring as exceptions to the general Anglo-Saxon type, is that of my friend, Dr. T. Sterry Hunt, F.R.S., the descendant of a New England family dating back nearly to the first voyage of the "May Flower." It suggests the desirableness of a minute comparison of head-forms of the old New England families. The experience of the New England hatters points, as we have seen, to the prevalence there of an unusually long and high type of head. But the percentage of native Americans of old descent even in the longest settled States must be small, situated as these are on the seaboard, and receiving the annual influx of emigration to fill up the gaps caused by wanderings of their own population into the new West. Indications of the development of a New England type, or variety of the Anglo-Saxon colonist have long been noted with interest; and minute data relative to the cranial type of the pure descendants of the earliest settlers would be of great value in their bearing on this subject. So

far, however, the diverse forms still clearly distinguishing the French colonists of the Quebec and Montreal districts of Lower Canada, rather indicate the permanency of the cranial race-forms, and their consequent value as a clue even to minute sub-divisions of the same nation, though severed for centuries from the parent stock.

THALLIUM.

The discovery of voltaic electricity by Galvani, and the application of this new power to the decomposition of chemical bodies by Sir Humphrey Davy, led to the recognition of a large number of elementary substances, the existence of which had been until then unsuspected. The preparation of the metallic bases of the alkalies, the alkaline earths, and the earths proper, is due either directly or indirectly to the application of galvanism, and no other force, no other method of analysis has been so productive of interesting discoveries as regards the ultimate constitution of matter. Recently, however, another branch of science, that of spectrum analysis, has bidden fair to be equally prolific in results, for although its birth dates but from a few years back (neglecting Talbot's experiments as not having led to any practical results) no less than three new metals, Caesium, Rubidium, and Thallium have already through its means been added to the list of the known elements.

The first two must often have been under the chemist's hands, but from similarity, especially in the platinochlorides, to potassium, have constantly escaped observation ; indeed the rare mineral Pollux, found in Elba, and supposed to be and described as a silicate of alumina and potassa has recently been proved by Pisani to be essentially a silicate of alumina and cœsium.

Cœsium and Rubidium exist only in exceedingly minute traces in the waters and minerals from which they are extracted, and although from their constant occurrences in certain vegetables, especially the beet-root, they cannot but be considered as essential to the growth of those plants, yet at present their investigation is by no means complete, and no useful applications have as yet been discovered for the

metals or any of their salts. Thallium on the other hand, which was discovered much later than the two last mentioned, is now manufactured in large quantities, has been tolerably well investigated and promises to be of considerable use in some of the industrial arts.

It is curious to remark that two if not three of these metals for the discovery of which we are indebted to spectrum analysis, should be found to belong to the class of the alkalic metals, for cœsium and rubidium are so similar as to be with difficulty distinguished from potassium, and thallium which was at first ranked with lead, is now by many associated with the alkalies or rather forms a connecting link between two groups, exhibiting some of the characteristic properties of both.

On this account thallium is one of the most interesting metals, and as the different papers describing its combinations are scattered through various journals, the following resumé may not be without interest to our chemical readers.

The new metal seems to have been discovered independently both by Mr. Crookes and M. Lamy, but the priority is due to the former, who discovered the element in March 1861, and had prepared several of its compounds as early as January 1862, and at the time of the exhibition in 1862 was quite aware of its metallic character, although M. Lamy had succeeded in obtaining it in a denser form exhibiting completely its claim to the character of a metal.

Both chemists obtained it originally from some seleniferous deposits from the chambers of a sulphuric acid factory, and as it will be recollected that Berzelius discovered selenium in his examination of such a deposit from Gypsholm it became interesting to ascertain whether that substance had contained thallium as it would not in all probability have escaped detection under the hands of so acute a chemist as the Swedish philosopher. Fortunately, Mr. Crookes was enabled to examine some of the original Gypsholm deposit, and found it to contain no trace of thallium.

The new metal seems to be very widely distributed, existing in native sulphur and in most pyrites, and in many other ores and commercial products. It has also been detected in the mineral water of Nauheim and in lepidolite and mica, although it has been objected that possibly the thallium may have been contained in the reagents employed, as was proved to be the case with arsenic some years since.

The principal source of thallium appears to be the different kinds

of pyrites, either iron or copper, and hence we find it both in the sulphur obtained from the first, and hence in many bodies derived from sulphur, and also in the copper obtained from the latter. Spanish copper seems to be especially rich in thallium. The richest pyrites examined was found to yield about 10 ounces to the ton, and the sulphur obtained from the ore about 10 grains to the pound. The sulphur is digested in caustic potassa till dissolved, the dark residue dissolved in sulphuric acid, precipitated by hydrochloric acid, again converted into sulphate, and the metal separated either by zinc or electricity. The easy solubility of the sulphate and the insolubility of the chloride render the separation of the metal on the large scale an easy operation.

In sulphuric acid factories, the thallium is carried away with the sulphurous acid, but is partly deposited in the flues, and much more might be obtained if the flues were made longer. This flue-dust seems to be the most convenient source of the metal, the quantity however is not large, as Mr. Crookes found only 1 grain in a pound of a seleniferous deposit.

Thus the thallium may make its appearance in common oil of vitriol and in hydrochloric acid; five grains have been obtained from a hundred weight of the latter. It may be detected in less than a pound of some kinds of hydrochloric acid by neutralising with ammonia, digesting with sulphide of ammonium, dissolving the dark precipitate in nitric and hydrochloric acid, reducing by sulphite of soda, and adding a few drops of iodide of potassium; a yellow colour or precipitate will be produced.

Thallium has also been detected in some dark coloured varieties of sulphide of cadmium, and in some salts of copper and bismuth. It has also been detected in tellurium.

Thallium has a perfect metallic lustre, but tarnishes rapidly in the air, the coating of oxide is readily removed by water, as in the case of most other metals by acids. It softens at a temperature of 100° C., and if kept at that heat, exhibits a crystalline structure, similar to that produced by the continued action of water.

Heated before the blowpipe, it melts and oxidises, giving off fumes of a white colour with a tint of red, the fumes continue to form after the heat is removed, as in the case of antimony. If a button of the metal be heated in a cupel, and introduced into oxygen, it will burn, the oxide being absorbed into the cupel as with lead. It is slowly

acted on by hydrochloric acid, rapidly by nitric and sulphuric, differing in this respect from lead. The metal is quite soft, and can be even scratched with the nail, when precipitated from its sulphate or nitrate by means of zinc, it forms crystalline plates. When thallium solutions are decomposed by electricity, brown peroxide is precipitated in which respect again it resembles lead, but the deposited oxide dissolves again.

The equivalent appears to be 204; this fact cannot be taken as any argument against the propriety of ranking thallium among the alkalic metals, as the equivalents of lithium, sodium, potassium, rubidium and cœsium are respectively 7, 23, 39, 85, 123. The position of the bright green thallium line does not correspond with any dark line of the spectrum, and hence we may conclude that this new element does not exist in the solar atmosphere.

By electrolysis it can be obtained in beautiful metallic crystals which if required in mass, can be squeezed and fused under cyanide of potassium. It is very malleable, but not very ductile, wires must be formed by squeezing the metal through tubes. The specific gravity is 11.9, which would certainly tend to separate it from the alkalic metals. The metal will mark paper like lead, but the marks soon become obliterated from the formation of the oxide, they may be reproduced by washing with sulphide of ammonium, when black sulphide of thallium is formed, which however also oxidises rather readily to sulphate; another point in which there is a certain resemblance to lead, and not to potassium.

Thallium may be ranked next to bismuth, as regards its diamagnetic properties.

It fuses at 550 F. (287 C.) and distils at a red heat. The crust formed on the metal by exposure is first yellow and then becomes dark, easily removed by water, and communicating to it a strong alkaline reaction, and a caustic biting taste. Owing to the same cause, the metal makes marks on turmeric paper, which soon become brown.

As regards its power of conducting electricity, thallium stands between lead and tin, the relative powers being respectively 7.77, 8.64, 11.45.

Quantitative Determination. If the thallium is present in the form of protoxide, it can be precipitated from its solution by bichloride of platinum, but this method is objectionable, inasmuch as the yellowish white double chloride is in such a fine state of division as to pass

through the filter. The best method is to precipitate the metal as iodide from strongly ammoniacal solution, it is best to precipitate at a temperature of 100°, to use solutions not too dilute, to allow the mixture to cool before filtering, and to wash out with ammoniated water. Werther denies that the iodide is soluble in excess of iodide of potassium, and only to the extent of $\frac{1}{4000}$ in water.

If the thallium is present in the form of teroxide, it can be precipitated by ammonia, the solution must be cold, and the washing continuous, otherwise a portion of protoxide is formed. The teroxide may also be reduced by sulphurous acid, and the metal precipitated as iodide.

Thallium and all its compounds communicate a brilliant green colour to the flame of a spirit or gas lamp, and if obtainable in sufficient quantity will doubtless be used hereafter for pyrotechnic purposes.

Protoxide is obtained by the action of baryta on the sulphate; it is easily soluble in water, attracts carbonic acid from the air, dissolves silicic acid, and hence cannot be kept long in glass vessels; the solution is strongly alkaline.

Peroxide is obtained by the action of ammonia on the perchloride, and is insoluble in water, and of a brown colour.

Protochloride is white, slightly soluble in water, fuses to a horny mass like chloride of silver, unchanged by exposure to light.

Apparently there are some other chlorides standing between this and the following compound :—

Terchloride is obtained by the action of chlorine on thallium under water, or by the long continued action of the same on the protochloride. The action must be continued until bichloride of platinum gives no precipitate. The chlorine is then driven out by carbonic acid, and the solution evaporated in vacuo. It cannot be produced by the action of aqua regia on the metal, as mixtures are formed of the proto and terchloride. The solution, when evaporated, deposits long colourless thick prisms, very easily soluble and deliquescent. The composition is $TlCl^3 + 2HO$, but the water cannot be determined by heating as a portion of protochloride is formed.

Iodide is precipitated by iodide of potassium, either of an orange-red colour or citron-yellow, according as the solutions are concentrated and hot, or dilute and cold. From a solution of acetate of potassium it is precipitated of an orange-red colour, and in small cubical crystals; they contain no water, fuse into a blackish-red liquid, and partly sub-

lime. Soluble in 20,000 parts of cold water. Iodide of potassium added to a solution of the terchloride forms iodide and iodine.

Bromide is similar to the lead salt.

Sulphide is precipitated perfectly from alkaline, only slightly from acid solutions; insoluble in alkalic sulphides, oxidises readily in the air to sulphate. The cyanide and ferrocyanide are insoluble in water, and apparently there are two carbonates, one soluble, the other insoluble.

Sulphate is obtained by dissolving the metal in sulphuric acid, or by acting on the chloride or nitrate with the same acid. It is anhydrous, easily soluble in water, and forms with sulphate of alumina an alum, crystalising in regular octohedra.

Apparently there are several phosphates, some soluble and others insoluble ; the nitrate is soluble, the chromate yellow and insoluble.

The compounds of oxide of thallium with organic acids are in general very similar to the salts of potassa, and of these Kuhlman has examined the oxalates, tartrates, racemates, acetates, malates, citrates, benzoates, urates, valerianates, and several others. A double salt containing antimony has been obtained corresponding to tartar emetic.

Double Sulphates.—By mixing sulphate of thallium with excess of sulphate of nickel, zinc, iron, or magnesium, double salts may be obtained having the same formula and the same crystalline form as the other magnesian double sulphates, a fact which is certainly a a strong argument in favor of ranking thallium among the alkalies.

The iron salt decomposes readily by absorption of oxygen ; the magnesium salt is also decomposed by repeated solutions; but the zinc and nickel compounds correspond most closely with those containing potassium instead of thallium. The formulas are :—

$$NiO.SO^3 + TlO.SO^3 + 6HO$$
$$ZnO.SO^3 + TlO.SO^3 + 6HO$$
$$FeO.SO^3 + TlO.SO^3 + 6HO$$
$$MgO.SO^3 + TlO.SO^3 + 6HO$$

Double Hyposulphite.—When chloride of thallium is dissolved in a boiling solution of hyposulphite of sodium, and the solution allowed to cool, long silky shining crystals separate, which can be washed with water and recrystalised. The formula was found to be

$$3\ NaO.S^2O^2 + 2\ TlO.S^2O^2 + 10\ HO.$$

Silico-fluoride has been obtained in distorted octohedra by digesting

carbonate of thallium in hydrofluoric acid containing much silicic acid. The salt is very soluble, and the formula has not been accurately ascertained.

From the above it will be seen that thallium well deserves the name given by Dumas—the "Ornithorhyncus of Metals," exhibiting about equally the characters of lead and potassium. The solubility of the oxide would lead to its being ranked among the alkalies, but it must be remembered that oxide of lead is not quite insoluble; and magnesia is ranked with baryta although virtually insoluble in water.

The solubility of the sulphate would tend to rank it with the alkalies, bnt the opposite character of the haloid salts and of the chromate would point to its classification with lead and silver. The existence of an octohedral alum would be greatly in favour of the first view, were it not that a silver alum has been prepared, but the existence of the magnesian sulphate containing thallium instead of potassium or ammonium is perhaps the strongest fact yet discovered in favour of its alkalic nature.

Thallium may be said to form one of the most curious connecting links between different classes of metals, standing between the lead group, to which it assimilates in its physical and many chemical properties, and the potassium group to which it is evidently closely related.

For analytical purposes it must be ranked in the second division of the second group, among the metals precipitated by hydrosulphuric acid from alkaline solutions, and forming sulphides insoluble in sulphide of ammonia.

H. C.

Almanaque para el año de 1863, *calculado para los Estados Unidos de Colombia por Indalecio Lievano, Encargadò del Observatorio Astronomico de Bogota.* Imprenta de echeverria Hermanos. Bogota. 1862.

A thin duodecimo of 64 pages bearing the imprint "Bogota." Perhaps some of our readers would be puzzled to tell at a word where or what Bogota may be. Our pamphlet might inform them

that it is a place where books are printed and sold, that it has an astronomical observatory and a military college, and that it lies in the United States of Columbia, a Republic of which the President for the year 1863 was *Tomas C. de Mosquera.* For further information the Gazetteer may be consulted. But before proceeding to examine our little volume inside, let us notice what knowledge we may pick up from the cover; accordingly here we read "*en esta imprenta se han dado a luz*"—notice the elegance of this little phrase, "*i se hallan de venta, las siguentes obras,*" and then follows a list of books, commencing with a "Grammar of the Castilian Language," —price in hard cash, $3.00; and including books of poetry, religion, law, commerce, a manual of politeness (*urbanidad i buenas maneras*), novels, dramas, a code of morals "founded on the nature of man," *juguete filosófico,* and winding up with a "Code of Love, or complete course of definitions, laws, rules and maxims applicable to the art of loving and being loved; by Agapito Canelon, Esquire,"—price $0.40. Thus we see the human insect

"Spins, toiling out his own cocoon,"

in Columbia much the same as in places better known to us. The concluding line of these advertisements is interesting to "us Britishers" as expressing in large capitals "Articulos de escritorio, manufactura *Inglesa.*"

Opening now our almanac, we find ourselves at once in a land of the "historic" faith, for we see that the first page contains the "ecclesiastical reckoning," the four *temporas,* or fasts, and the moveable feasts of the Church. Curiously enough, under the first heading are included the dates of the Jewish and Mahomedan eras, and the Turkish fast or Ramadan, reminding us how closely connected were these races with the Spaniards of old. Then follow "chronological notices," giving an account of the origin and calculations of the dominical and golden letters, the epact, &c., and, we must acknowledge, with a fulness and clearness which we have never met with in any English work. A few important dates in the world's history are added and we are told that "good chronologists count five epochs for the understanding of history, sacred and profane." Students might guess long what these five were, before they lighted on the following:—The taking of Troy, the foundation of Rome, the conquest of Carthage by Scipio, Constantine or the peace of the Church,

Charlemagne or the re-establishment of the Empire. Then we have the usual astronomical notices of eclipses, and an extremely well-written and correct article on the different kinds of solar time, and then to the calendar proper, each month being headed by a rude wood-cut of its proper constellation, and each day connected with some saint or martyr, or with ecclesiastical regulations, and the moon's ages and sun's signs interspersed.

A table of meteorological observations at the observatory of Bogota, for the months of October and November, 1862, gives some interesting results. In October the mean temperature of the air was about 60½ degrees Fahrenheit, which is about twelve degrees higher than at Toronto for the same period, though it must be remarked that the observations at Bogota were taken in the daytime and are thus unduly exalted above the Toronto ones, which include 6 A.M. and midnight; but Bogota seems less subject to those sudden changes which make the climate of Toronto so trying—the extreme deviation in the former place being about 9 degrees while in the latter it is no less than 44. The amount of rainfall was 6·36 inches, while at Toronto it was about 2⅓, but at Bogota nearly the whole fell between the 20th day and the end of the month. Similarly, the mean temperature for November was 59°.8, contrasting with 35°.6 for Toronto, and while the extreme range for Bogota appears to be about 5 degrees, that of Toronto is nearly 40. The rainy season continues during this month, the fall being upwards of nine inches, with only four fair days throughout, while at Toronto the fall (including snow) was under three inches, and there were fifteen days without either snow or rain. The mean height of the barometer is about twenty-two inches, and Bogota must therefore be situated at an immense height, some eight or nine thousand feet, above the sea-level; our author in conjunction with *el Señor William Chandless, illustrado viajero* (the rough Saxon vocables sound oddly amidst the smooth Castilian) has determined the height above Honda to be 2439 metres, but he says that he waits for the observation of the Señor Chandless at Carthagena, in order to determine the height of his observatory above the sea.

In a page surrounded with black lines our Almanac mourns the *perdida irreparable*—the irreparable loss—caused by the death of the illustrious and modest Señor Lino de Pombo (who appears to have been a mathematical Professor in the military college of Bogota)

and in eloquent language, replete with the courtesy and pomp of the old Spaniard, expresses his sorrow :—

"Si en las naziones que van a la vanguardia de la civilizacion i del progreso, i que cuentan con multitad de individuos versados in las ciencias, es siempre mui sensible i lamentable la pérdida de uno de ellos, qué no será en la naciente Colombia la pérdida de un sabio, i de un sabio como el Señor POMBO!—Mútis, Caldas i Pombo!! . . existencias preciosas!! . . Tres veces hase viso eclipsado el horizon de Colon . . ; en la tercera, es el Sr. POMBO que nos deja para volar a la mansion eterna!!"

Three articles remain to be noticed, still by the same author, two of which are mathematical, dedicated to the College of Engineers of the Republic of Venezuela. In the former of these, the subject of incommensurables is attempted to be treated in an elementary manner, reference being made to "mi aritmética," and in the latter a "rigorous demonstration" is given of the formula for compound interest (which question is treated in "mi áljebra autógrafa") by proving it in the cases when the index is fractional or incommensurable (though the case of it being negative is omitted); but the remaining article is remarkable enough to claim a translation. It is entitled "a rigorous demonstration of the existence of the deity, given by Indalecio Liévano in the year 1856," and we must crave the author's indulgence for the inevitable defects which accompany a transmutation of the delicate Spanish auxiliaries into our own limited English. He sets out with the axiom that "what is evident is true" —*(lo evidente es vesdadero)*—from this, he says, comes the existence of the *ego (del yo)* because even if all which is presented to my thoughts were a vain play of my imagination, yet I could not doubt of my own existence—it is *evident* to me. This being laid down, the following series of propositions is thus enunciated and proved :—

PROP. I.—*Something has always existed.*

For, if at some time nothing existed, since from pure nothing, nothing can proceed or begin to be, there never could have existed anything; but since something (namely—*el yo*—the *ego*) does now exist, therefore something has always existed.

PROP. II.—*It is necessary that at some time something has existed.*

Because the possibility of non-existence requires a beginning for being able to be or not to be; therefore, something having always ex-

isted, the possibility of the nothing (or absence of existence) ceases, and there remains the *necessary* existence of something.

PROP. III.—*A being which has in another distinct being the cause of its existence, might have not existed.* (*Ha podido no existir.*)

Because if its existence were *necessary*, it would exist as a necessary consequence of the other being, and would then be a necessary part of it, and not a distinct being, which is contrary to supposition.

PROP. IV.—*Some being has existed which has had in itself the cause of its existence.*

In effect, if no being had had in itself the cause of its existence, every being would have had in another distinct being the cause of its existence; but since a being which has had in another distinct being the cause of its existence might have not existed (*Prop.* 3.), it follows that the existence of something would not be *necessary*, which is contrary to Prop. 2; therefore it is false that no being has had in itself the cause of its existence; and therefore some being has existed which has had in itself the cause of its existence.

PROP. V.—*A being which has had in itself the cause of its existence*

(1). . . . *Cannot have had a beginning :—*

For if at any time it did not exist, then in passing from non-existence to existence, it must have had in another being the cause of its existence, which is contrary to supposition.

(2). . . . *Is a necessary being :—*

Because if it were not so, then since the remaining beings, which have had in another distinct being the cause of their existence, might have not existed (Prop. 3), it would follow that it was not *necessary* that at some time some being should have existed, which is contrary to Prop. 2.

(3). . . . *Cannot have an end :—*

Because its existence having been *necessary*, there is no reason why the prolongation of its existence should cease to be *necessary*.

(4). . . . *Is infinitely wise :—*

Because, from having in itself absolutely the cause of its existence, it is plain that it has an exact knowledge of its own essence; this knowledge requires an exact knowledge of all the remaining essences because they all have some relation among each other, and one of them cannot be exactly known without knowing in the same manner all the rest.

(5). . . . *Is infinitely powerful:*—

Because being infinitely wise, it knows all the means of effecting all that is possible, (*de realizar los posibles.*)

CONCLUSION.—*A being, necessary, eternal in both senses, omnipotent and omniscient, and which we call the Deity, therefore exists.*

With the quasi-mathematical form of this reasoning, readers of metaphysics are familiar, from the days of Descartes and Spinoza down to the late lamented Ferrier, but the substance of the above is remarkable as being almost a reproduction of the argumentation of Dr. Samuel Clarke, in his "Demonstration of the Being and Attributes of God," a work which is unsurpassed for acuteness, depth, and we may add, difficulty. That our readers may judge of the parallelism, we append part of the chain of propositions which Clarke sets out to establish. Prop. 1. *Something has existed from eternity.* Prop. 2. *There has existed from eternity some one immutable and independent Being.* Prop. 3. *That immutable and independent Being, which has existed from eternity, without any external cause of its existence, must be self-existent, that is, necessarily-existing.* These latter two propositions are identical with Props. 2–4 of our author. In Clarke's Prop. 2. "some one" must be interpreted as "some one at least." Prop. 6. *The self-existent being must of necessity be infinite and omnipresent.* Against the demonstration of the latter part of this proposition, an ingenious objection was urged by Butler, who afterwards was the famous author of the Analogy, and it is said by Prof. Boole that "it does not appear that Dr. Clarke was ever able to dispose effectually of this objection." This however is a mistake, as Butler acknowledges himself satisfied on this head in his Letter IV. It was to an objection made by Butler against the subsequent proposition that Dr. Clarke does not appear to have made a satisfactory reply. Prop. 7. *The self-existent being must of necessity be but one.* Prop. 8. *That the self-existent and original cause of all things must be an intelligent being.* Prop. 9. *Is not a necessary agent, but a being endowed with liberty and choice.* Prop. 10. *Must of necessity have infinite power.* Prop. 11. *Must be infinitely wise.* Prop. 12. *Must have all moral perfections, such as become the Supreme Governor and Judge of the World.*

It will thus be seen that Señor Lièvano can hardly be credited with originality in his demonstration, but the manner in which he has condensed Clarke's reasoning is very remarkable. With regard

to the sufficiency of these and all similar arguments *à priori*, it is difficult to express an opinion, so much depending on the use of words, to which no distinct idea appears to be attached, and on grasping the forms of ideas of which the outlines seem to be in constant fluctuation. Hallam confesses that he was never able permanently to satisfy himself whether the celebrated argument of Descartes on necessary existence was sound, or merely a play on words. And a distrust of such arguments is still more forced upon us when we see how they issue when applied to physical subjects: no philosopher of the present day but would smile at Clarke's discussion of the nature of *motion* and his proof of the necessary existence of a vacuum, and yet it would be hard to draw a line between his reasoning in these cases, and that used in other parts of his demonstration. Prof. Boole writes (Laws of Thought, p. 216) "It is not possible, I think, to rise from the perusal of the arguments of Clarke and Spinoza without a deep conviction of the futility of all endeavours to establish, entirely *à priori*, the existence of an Infinite Being, His attributes, and His relation to the universe. The fundamental principle of all such speculations, viz., that whatever we can clearly conceive must exist, fails to accomplish its end." And though it may be doubted whether Boole has here laid his finger on the precise cause of the futility, yet it would seem that even metaphysicians in the present day virtually accept the result, and rely on the *à posteriori* arguments which depend on the sober procedure of analogy and probable induction. All these may be summed in the dictum of Newton at the close of his immortal *Principia*—"Deum summum necessario existere in confesso est; et eadem necessitate *semper* est et *ubique*"—remembering that this *confessio* is derived from a contemplation of the harmony which pervades the celestial system and which "could not spring from any thing than the design and government of an intelligent and powerful being."

We cannot help remarking the siugularity of the fact that an argument so profound as this of Señor Lièvano, and apparently so little calculated for popular appreciation should appear in a mere everyday hand-book such as this calendar is, and adapted for circulation among a people to whom we are not generally inclined to ascribe a high degree of civilization. Neither can we omit to remark the combination in our author of metaphysical and mathematical attainments, a combination in old times so common, now-a-days so rare,

and to which rarity may possibly be assigned the depreciation of the former study, now too general, yet hardly to be wondered at, when we see the hopeless floundering of metaphysicians of the Hamilton kind over problems which a sprinkling of mathematics would at once dissolve. In conclusion, Señor Lièvano will permit us to stretch a hand to him across the equator, and greet him heartily and with all good wishes for success, as a fellow-laborer in the field of knowledge.

J. B. C.

PLANTS AND THE ATMOSPHERE.

BY M. J. JAMIN.

(*Translated from the "Revue des deux Mondes," Sept.* 15, 1864.)

Those who have not devoted themselves to the physical sciences will pardon me if I take the liberty of reminding them that the air, in the midst of which plants and animals live, is a mixture of two very different gases. One, almost inert and without any appreciable influence upon natural phenomena, is called nitrogen. The other, on the contrary, possesses most active properties and plays the foremost part in the maintenance of life upon the globe: this is oxygen. Among other properties, it has that of forming an intimate union with carbon, and during this union, or to employ the scientific term, while this combination is being effected, a considerable quantity of heat and light is evolved. We say that carbon *burns;* and it might, at first sight, be thought to be annihilated; but really it only transforms itself into a gas, which mingles with the atmosphere, in which latter chemistry recovers, at the same time, all the carbon which has been burnt and all the oxygen which has united with it. The name of carbonic acid has been given to this compound gas, in order to recall its origin and composition.

Wood, which is essentially composed of carbon and water, burns in the same manner by abandoning the water, which evaporates, and by transforming the carbon into carbonic acid. Fruit, vegetables, bread, all nutritive substances having a chemical composition analogous to that of wood may, like it, be burned in a furnace, and Lavoisier informs us that the substance of these articles of nutrition undergoes a real but slow combustion in the respiratory system of the animals which feed upon them. Every animal, then, is a furnace; every nutritive substance, a combustible; in respiration, oxygen is absorbed from the air, it is replaced by carbonic acid and the water is rejected either by natural channels or by exhalation.

Since carbonic acid is necessarily generated by animal life, it ought, undoubtedly, to form an integral part of our atmosphere. Accordingly, chemists find it there, but in the minute proportion of from four to five in ten thousand. It is a gas which is incapable of maintaining either life or combustion, being, on the contrary, the effect of both. Thus, all animals placed in a receiver filled with air

rapidly exhaust the oxygen which they replace by carbonic acid and soon die, not by a poisonous effect of the gas, but from want of respiratory nourishment.

Having thus recalled these facts, I shall now proceed to describe a famous experiment, which, without our knowledge, plants are unobtrusively performing among us; which is accomplished upon an immense scale; and which may rightly be considered one of the most essential phenomena in the world: an experiment otherwise so simple that every one is able and must be willing to repeat it. In order to succeed, take a fresh and sound leafy stem of the aquatic plants which are to be found growing submerged in ponds and rivers, place it in a white glass decanter filled with spring water or better still, with diluted Seltzer water which, as we are aware, contains a great proportion of carbonic acid in solution. Having corked the filled decanter, invert it, so as to introduce the neck into a vessel filled with water. The cork may then be withdrawn, the water remaining undisturbed and continuing to fill the inverted decanter. The apparatus being thus prepared, remove it to an open place where it may receive the rays of the sun.

As soon as the light strikes directly upon the leaves of the immersed plant, they will be seen covered with a multitude of bubbles which rapidly increase in size, unite, and rise to the top of the vessel where they accumulate. Whenever the light is intercepted by an opaque screen, this disengagement ceases, and by alternately covering the apparatus with light or shade, even at a distance, the current may be reproduced or stopped, at will. After several hours of continuous action, the decanter is filled with this gas. It resembles air but has not the properties of air, for if the vessel being returned to its original position, a slender wax taper, just extinguished and still retaining at the end of the wick some red points, be immediately introduced, it will, at once, rekindle and continue to burn with unusual brilliancy. This gas, then, is not air but oxygen. The same experiment may be reproduced with aerial plants, and, in order not to change their habitual condition, they should be exposed to the sun under glass receivers filled with carbonic acid. After a day this gas will disappear and will be found to be replaced by nearly pure oxygen. Whatever the plant may be, whatever the experimental process, the action always remains identical, and the explanation of this important fact is evident. The green parts of plants decompose carbonic acid; they extract from it the carbon which they retain, and reject the oxygen which they return to the atmosphere. In darkness and during the night, their action changes. Far from absorbing carbonic acid they exhale it; but this nightly reaction being inferior to the diurnal action, plants finally accomplish a part diametrically opposed to that performed by animals. They destroy the carbonic acid which they form, they generate anew the oxygen which they absorb and thus reproduce the organic matter which they consume.

At the sight of so perspicuous an experiment and of so simple an explanation, it seems that scientific men ought to have discovered them from the very first. It would, however, be a strange delusion to believe that such was the case. No great discovery is made without cost to humanity. At first, all is obscurity and impotence; it is only after long investigation that, amid much hesitation, a glimpse of some scattered truth is caught, and, until the moment when a serene light

comes to clear up all obscurities, there is need for the collected labors of severa generations and the co-operation of many men of genius. It is not uninteresting to study the history of these great discoveries, and I here undertake the recital of the successive experiments which have determined the relations existing between plants and the atmosphere; I shall continue it as far as the recent labors which have recalled attention to the subject of which I treat.

I.

Charles Bonnet, a physician of Geneva, towards the middle of the 18th century, was the first to enter, experimentally, upon the problem which occupies us. It was the reading of a then celebrated work "Le spectacle de la Nature" by Pluche which decided his profession. He, at first, occupied himself with the subject of spontaneous generation, a question already debated at that period and of which, time has but served to inflame the discussion. He relinquished this subject in order to treat of another, of which, perhaps, he did not foresee the prolific nature; he asked himself what is the function of leaves, and made two experiments that have since remained classic. By the first, he proved that light exercises upon the green parts of plants so lively an attraction that, being placed in darkness, they direct and incline themselves towards the least openings which bring daylight to them. The second demonstrated that, on being plunged into water, plants give forth, under the influence of the sun, a great quantity of air; but at this point the discoveries of Bonnet were stopped; he did not know what that air was and could not know it, since, at that period, the world was in utter ignorance of the first principles of modern chemistry.

Priestley, who was the rival, and, in some respects, the predecessor of Lavoisier, was brought, by the very results of his discoveries, to study the action of plants upon the atmosphere. He had just isolated the remarkable gas which energetically maintains the combustion of candles and the respiration of animals, and, for this reason, he had called it "vital air." He had, besides, discovered that small animals shut up either in this or in atmospheric air, soon changed the properties of these to such an extent that the animals ceased to live and that candles were extinguished by the gases. But in reality, Priestley was not aware of the true nature of oxygen, and, by a blind feeling of rivalry, refused all his lifetime to adopt the theory of respiration just published by Lavoisier; but he knew, nevertheless, how to deduce from his experiments a logical conclusion of the greatest importance. Observing that these little animals vitiated the confined air by their exhalations, he concluded that every individual of the animal kingdom produced, in a continuous manner, the same effect upon the entire atmosphere, and that they would infallibly die in it were there not in the play of natural forces an inverse continuous action tending to restore the air to its original purity, in proportion as it is vitiated by animal respiration. This counterbalance, this regenerating action he sought and found in plants. Under an air tight bell glass filled with air he placed an animal and a plant. The former corrupted the air and died; but at the end of a certain time Priestley discovered that the latter had restored to the air its vital property or the purity necessary for the support of life. It was one of the most important facts in the world's mechanism. From this moment it was known, without as yet entering into

the details, that plants and animals perform opposite functions, the latter rendering air unsuitable for the support of their life, the former repairing this evil. The Royal Society of London, in 1773, offered Priestley the Copley medal, and, in presenting him with it, the president of this famous body thus characterized Priestley's discovery: "Plants do not grow in vain; each individual in the vegetable kingdom, from the forest oak to the grass in the meadows, is useful to mankind. All plants preserve our atmosphere in a degree of purity necessary to animal life. Even the forests of the most distant countries contribute towards our preservation by feeding upon the exhalations from our bodies which have become injurious to ourselves." The glory of Priestley was, however, doomed to be obscured. After such noble exertions, views so great and so general, after these public rewards and eulogiums, Priestley, one day, took it into his head to repeat his first experiments and obtained results diametrically opposite, that is to say, that plants, instead of purifying the air, seemed to him then to render it more impure. Astonished at this inexplicable contradiction between the past and the present, he multipled his tests by varying them and the only thing that he was thereby enabled to affirm was, that plants exhibit, alternately, the property of purifying and that of vitiating the atmosphere. The law, therefore, which had won for him the Copley medal was not a general one, and the consequences which he had drawn from it were liable to dispute. Seeking refuge in America, Priestley died in 1804, after a life agitated by religious discussions, having made great discoveries in chemistry which he had not understood, and in vegetable physiology, contradictory experiments that he was unable to reconcile. Priestley, however, was noway mistaken; plants do, in reality, perform alternately the two functions which he had assigned to them, and the only thing that he had not discovered was the condition which determines the occurrence, often, of the one, the repairing function, and sometimes, of the other, the deleterious action; a condition of which Bonnet had caught a glimpse and which Ingen-Housz was about to make perfectly clear. Ingen-Housz was born at Breda, in 1730; he was a physician, and went to England to study inoculation for small pox which was then beginning to draw attention. It was in this voyage that he placed himself upon the track of Priestley's labors and that he resolved to explain their contradictions; he found the cause of them in 1779, and here is how he sums up his own discovery: "Hardly was I engaged in these researches before the most interesting scene opened up before my eyes. I observed that plants have, not only the power of correcting the impurity of air in six or more days as the experiment of Mr. Priestley seemed to indicate, but that they acquit themselves of this important duty in the most complete manner within a few hours; that this wonderful operation is not in any way due to vegetation, but to the influence of the sun's light upon plants; that it only commences some time after the sun rises above the horizon and that it is entirely suspended during the darkness of night; that plants shaded by high buildings or by other plants do not acquit themselves of this duty, that is to say, do not ameliorate the atmosphere, but, on the contrary, exhale noxious air and spread veritable poison in the atmosphere which surrounds us; that the production of good air begins to languish towards the close of the day, and entirely ceases with sunset; that all plants corrupt the surrounding air

during the night; that all the parts of plants are not employed in purifying the air but only the leaves and green branches; that acrid, fetid and even poisonous plants acquit themselves of this office equally with those which give forth the sweetest odors and are the most wholesome, etc.*"

Ingen-Housz attained also to the discovery of the force which determines the respiration of plants; this force, which had not even been guessed at, comes from the sun; it is light. It diffuses itself in leaves, which absorb it, and accomplishes the immense work of regenerating the atmosphere. Henceforward, the most important as well as the most difficult step was taken; but there still remained fully as much to be performed. The sciences may be compared to the tub of the daughters of Danaus; each labors to fill it and none succeed, because every discovery unveils a new horizon and removes farther away an end which is never attained. According to Ingen-Housz, the question ought to be asked and was indeed asked; what is this change, determined in the atmosphere by animals, and in what does the remedy which plants apply to it consist? It is the duty of chemistry to reply, and, although he had not specially devoted himself to that science, it was Lavoisier who gave the solution of this new problem. He found it, the day on which he demonstrated that animals absorb oxygen, slowly consume the organic substances on which they feed, and give forth, by expiration, a quantity of carbonic acid containing all the carbon which they have consumed. Vitiated or corrupted air, as Priestley and Ingen-Housz called it, was, therefore, air deprived of oxygen and charged with carbonic acid, and, since plants purify it, this fact seemed incontestably to show that they decompose carbonic acid, retaining the carbon and restoring the oxygen to the atmosphere.

Judging from the point to which chemistry had then attained it would seem that everybody might have divined and made public this explanation. It was not so however, and new experiments were still necessary in order to its discovery. It was a Genevese who had commenced this long campaign and it was another Genevese who had the honor of terminating it. His name was Sennebrier; he had been the friend of Charles Bonnet; it was owing to his example that he had embraced science, and, to his counsels that he studied the relations of plants to the atmosphere. He found that plants placed in water which had been boiled do not evolve any gas to the sun, but that they develope an abundant supply of oxygen when this water has, beforehand, been charged with carbonic acid. He thence concluded that this gas is necessary to the respiration of plants, that it is decomposed by them, and thus he had the glory of giving a formula to the law already prepared and discovered by his predecessors. The question might then rightly be considered as solved; but, during these researches, which had lasted for more than half a century, many errors had crept in among the truths acquired, and contradictory assertions still left ample field of doubt upon various points of detail. A review of all these phenomena was necessary; this was undertaken by Th. de Saussure, who, without adding any crowning fact to the pile of former acquisitions, succeeded in giving to them an experimental confirmation that has not since been contested. After these celebrated experiments there was a long

* Expériences sur les végétaux, par T. Ingen-Housz, 1780.

repose. Physicists and naturalists seemed to regard the question as exhausted and withdrew their special attention to subjects which they considered more fertile. However, the more recent labors of Messrs. Daubeny, Draper, Cloes and Gratiolet, and above all of M. Boussingault have successively been undertaken to remove disputes undecided to the present day; but I desire to omit all that is not specially connected with the general theory; I shall treat neither of nitrogen, which plants seem always to give forth at the same time as oxygen, nor of certain deleterious gases such as carbonic oxide and carburetted hydrogen which M. Boussingault has just found among the products of their exhalations, nor, finally, of the experiments made without much success in order to estimate the special influence of different solar rays. What I desire to shew is, that, after the early studies just alluded to, we find ourselves face to face with a second series much more vast and complicated, upon which we must now enter. We must endeavor to find what becomes of the carbon that remains in plants after the decomposition of carbonic acid.

II.

While the atmosphere furnishes leaves with carbon, the branches supply them with water, which has been drawn up from the soil, and it is natural to think that these two bodies meeting one another, would mutually combine; they do, in fact, combine, but in very variable proportions; let us cite a few examples. If 12 atoms of carbon unite with 10 atoms ot water, they may give birth, either to cellulose, which at the same time constitutes the cells and the whole skeleton of the plant, or to starch, with which everybody is acquainted, or, finally, to dextrin, which is valuable, and of which syrups are sometimes made; but, according to circumstances and organs, the proportion of two bodies may change, and with that the chemical products to which they give rise. Thus, 12 atoms of carbon combined with 12 atoms of water constitute glucose or grape sugar, which is found in ripe grapes, and if, from this glucose, two atoms of water be taken away, the result will be cane or beet sugar. In a word, by processes unknown to us, water and carbon meeting in leaves, form a chemical union, and produce an infinite variety of compounds, according to the position, organs, nature, age and exterior conditions of the plant.

Besides the substances just mentioned, and which are composed of carbon and water, plants create another class characterised by an excess of hydrogen. These are fats, oils, resins, balsams, volatile oils, &c. Whence comes this hydrogen? They also form compounds in which appears a fourth element, nitrogen; does it come from the atmosphere? Is it imbibed from the soil? These are questions directly affecting agriculture, and upon which it is obliged to consult chemistry.—The first and the best treatment of these questions is due to M. Boussingault, who found himself most happily situated for the purpose, being at once placed at the head of a great agricultural commission, and habituated to the most delicate operations of chemical analysis. The method employed by him is peculiar to himself; it is so general and fruitful as to apply to the requirements of all individual cases. Here is what it consists in. In soil analysed beforehand is sown a small number of seeds, of which the chemical composition has been determined, and these

are sprinkled with pure water. The latter disappears almost entirely by evaporation, a very small quantity only remaining behind. The plant increases in size, and gains in weight since it receives nourishment from the air, and also because it takes it from the soil. At the end of a certain period of growth, it is gathered, and then measured by new chemical analysis; first as to how much carbon, oxygen, hydrogen, and nitrogen it has gained; secondly, as to how much of these substances the soil has lost, that is, how much it has given to the plant. The difference is due either to the air or to the water. This comes in to equalize the account, and in fine, to settle the balance of profit and loss.

The application of this method, as vigorous in conception as it is difficult in application, has revealed a primary fact of the same order as the decomposition of carbonic acid. All plants have acquired an excess of hydrogen that comes neither from the soil, nor from the air which does not contain it; of necessity, therefore, it must have been derived from the water. Plants therefore do not limit their action to the separation of oxygen from carbon, they also disunite hydrogen and oxygen, retaining the former and rejecting the latter. The water was hydrogen burned, just as the carbonic acid was carbon consumed; in both cases plants have destroyed the effect of combustion by restoring the combustible bodies to the state in which they were before being burned. In establishing this action finally exercised upon water, no success has yet been attained in the knowledge of when it is effected, and in what organs it is accomplished.

A second consequence follows from the analyses of M. Boussingault, namely, that every plant at maturity has gained some nitrogen which betakes itself principally to the seeds; as this nitrogen may come either from the air, which holds it in a free state, or from the manures mixed with the soil, it was necessary to inaugurate special experiments in order to determine its origin. M. Boussingault set to work in the following manner: at first he sowed some clover in soil exclusively constituted of calcined sand, which alone was intended to furnish the growing plant with mineral matter, and with pure water by which the sand was moistened; as for nitrogen, none was contained in it. Under these exceptional conditions the clover, nevertheless, accomplished all the stages of its growth, and finally acquired a feeble but certain proportion of nitrogen which necessarily must have come from the atmosphere. Artichokes gave the same result with greater degree of nicety. When ripe they contained twice as much nitrogen as the seeds from which they sprung; but when it was attempted to reproduce the experiment with cereals, and especially with wheat, the result was that the nitrogen of the seed was tenaciously preserved, but in no degree augmented.

In every case the growth of the plant was extremely difficult, none of them having that healthy aspect exhibited by them in a rich soil; the artichokes, however, suffered less than the clover, and it again less than the wheat which could not even develope ripe grains. The reason of this is evident, nitrogen was wanting; all plants require it, wheat must have it, and when they do not find it in the soil they languish and frequently die. Finally to confirm this conclusion, M. Boussingault subjected to a comparative test three plants of the Sunflower (Helianthus) set in three similar pots filled with pure sand and moistened with pure water. To the first no manure was given, to the second 8 centigrams (1.2344 of

a grain), and to the third 16 centigrams (2.4688 of a grain) of nitrate of potassa. From the very first the three plants betrayed the difference in treatment to which they had been subjected: the first languished and died, the second developed itself, although stunted, but the third was remarkable for its healthy condition. At maturity the second had taken from the soil 4 centigrams of nitrate of potassa, and the third 8. But what was especially remarkable was, that, during its existence, the latter decomposed twice as much carbonic acid as the former. Thus did the nitrogen perform the office of stimulating the other functions, and of giving to the subject which received it, or of taking away from that which was deprived of it, the vitality, without which it would not act upon the atmosphere.

Now, let it be observed that a plant contains more than half its weight of carbon, and only some thousandth parts of nitrogen. What purpose, then, in vegetation does this substance serve, being necessary to it, and yet introduced into it only in so small a quantity? M. Payen will inform us. According to this skilful chemist, all vegetable organs originate in a nitrogenous substance analogous to fibrine, to which, little by little, are added the fibrous and cellular tissues which, expanding, produce the whole plant. This fibrine is never destroyed, is formed in all the organs of the plant, and must thus be the rudiment of all its parts which could not be developed without it, and, consequently, without nitrogen which is its essential basis. To recapitulate, plants are composed of carbon, water and an excess of hydrogen; they contain, besides, a fourth simple body, nitrogen, found in a very small proportion, but the presence of which is necessary to life. The atmosphere furnishes carbon abundantly; water, that is to say oxygen and hydrogen, is contributed by rains; nitrogen is required from the soil, and since it is rarely to be found there it must be introduced in the form of manures; this is the great business of the agriculturist, the largest, most unavoidable and most productive of his outlays.

III.

In spite of the solid information which we possess upon the subject that occupies us, we cannot but declare upon many points the inadequateness of our knowledge. One of the most inexplicable facts, and one that ought most to awaken our curiosity and to demand our investigation, is the great physiological fact, the discovery of which I have narrated. Chemists have admirably studied carbonic acid; they know all the properties it possesses, they are able to foresee all the reactions it occasions or undergoes under every condition in which they please to place it; they are ignorant of none of the circumstances which give birth to or destroy it. However, they have never seen it decomposing in a cold state, under the influence of light, in the presence of any inorganic matter whatever, and what they are unable to do, the smallest leaf exposed to the sun performs immediately with a rapidity and an abundance that fill the naturalist with admiration. In ten hours, an aquatic plant gives forth fifteen times its volume of oxygen: a single leaf of the water-lily (*Fr. nénufar*) exhales 300 litres (a litre being 1·760 pint) every summer, and M. Boussingault, having poured into a vase, filled with vine leaves, exposed to the sun, a current of carbonic acid, collected at its exit only pure oxygen. Ah well! we must just confess that this fact so common, so easily

accomplished by leaves, every hour of the day, is one which chemistry can neither understand nor imitate.

If we cannot succeed in seizing and imitating the conditions of a fact relatively so simple and so well defined, what must be our embarrassment when we would analyze the chemical and physiological phenomena which result from it? We see in fact three simple bodies, rarely four, combining in indefinitely variable ratios, and giving rise to the most numerous and most different compounds; wood, starch, sugars, oils, wax, balsams, essential oils of agreeable odors, and infectious matters, delicious fruits, and violent poisons, acids such as vinegar, and alkalies as quinine or strychnine, substances coloring and colorless, and, in general, substances of which the infinite variety surpasses all that the imagination can conceive of. It is not without dismay that we measure the depth of our ignorance in the presence of such multiplied phenomena, the mechanism of which altogether escapes our grasp.

There are, however, certain ill-disciplined minds that would explain everything, and above all, matters of which they are most ignorant. It has been said that plants probably contain compounds of carbonic acid and nitrogen, forming during the night and decomposing under the influence of light; it has also been stated that there exists in green leaves a sort of fermentation deriving its activity from the sun and having for its special function the decomposition of carbonic acid. These explanations have not only the defect of being illusory and conjectural, they are also false, for, according to them, pounded leaves preserving the same composition ought to continue the same functions, which is not the case. There is also a whole school of naturalists who content themselves with attributing the vegetable functions to what they call *life*, a kind of inaccessible force which should suffice to explain everything by the sole virtue of its name: these appear to me to renounce every description of scientific progress, like the ignorant bigots who explain all phenomena by saying that it is God who makes them. Without doubt God regulates the world, but He allows us sometimes, to contemplate the machinery. Undoubtedly, also, it is life that regulates the functions of beings; but before proposing it as the final cause and ultimate explanation of facts we must know a little more what it is and what are the means it employs. It is easily seen to what feebleness we are reduced as soon as the ground of experiment fails us, when to fill up the vacuum in our knowledge we take refuge in hypotheses, in unexplained and unexplanatory forces. Let us be true: we are ignorant; let us confess it, and gird up our loins and search!

To console ourselves for this avowal, which might be painful to our self love, to encourage us in our labors of the morrow, let us, in dwelling upon their results, measure the importance of the discoveries actually made. If plants give forth oxygen, animals absorb it, and compensation is thus established between these inverse functions. This might be experimentally demonstrated by enclosing under a bell glass an animal and a plant. Separately, each of them would die the first by drowning itself in the carbonic acid it would exhale, the second, because deprived of this gas which nourishes it. Brought together in darkness, the animal and the vegetable would injure instead of assisting one another; but, under the influence of the sun, the life of the one would support that of the other;

the animal consuming its nourishment would furnish carbonic acid to the plant, and the latter would restore to the animal the oxygen necessary for it. This experiment would be a small model of the world, and it is thus that Priestley understood its eternal equilibrium. Nothing is greater or more beautiful than this thought, but it requires completion. If the bell glass of which I have just spoken were very small, the least excess arising in the respiration of the animal or the least interruption in the action of the sun would so augment the quantity of carbonic acid as to cause first the animal and afterwards the plant to perish. Are we then exposed on the earth to a similar danger and are plants so necessary, to us that we should cease to live as soon as they cease to act? This cannot be, and I am about to show that the fear of it is vain. The human population of the globe may be approximately estimated at a thousand millions of individuals, and it would not be far from the truth to admit that all other animals taken together exercise upon the atmosphere, by their respiration, an effect equal to three thousand millions of adult men. That makes for the entire animal kingdom a population equivalent to four thousand million human beings. The average quantity of oxygen consumed by an adult daily, being measured, it would be easy to calculate that consumed by the whole population of the globe. It is without doubt very great, but, on the other hand, the supply of oxygen in the atmosphere is greater still. It is so far beyond the consumption of animals that it would require eight thousand million years to exhaust it. In eight centuries the thousandth part only would be wanting, and, if plants were to cease their action, it would require at least two thousand years for the most precise chemical analysis to succeed in perceiving a change in the composition of the atmosphere. The service, therefore, which plants render is much less immediate than Priestley thought; it is a service with a long date, and we may without ingratitude bequeath our thankful acknowledgment to posterity.

But the earth is very old and it is not impossible that its atmosphere may have undergone since the creation progressive changes, which by the long addition of bygone ages must have become very considerable. This is a curious question that has been treated of by M. Adolphe Brongniart and which we are now about to study with him. The earth conceals enormous and so to speak inexhaustible masses of carbon under the form of coal, anthracite, lignite and peat, and it cannot be doubted, for a single moment, that these deposits are the accumulated fossil remains of innumerable plants. Since there is but one way in which a plant can acquire carbon, that is, by taking it from the carbonic acid in the atmosphere, it follows that all the masses of coal, which cover Belgium, England, and a great part of America and which are found in every corner of the globe, were formerly diffused throughout the atmosphere in a gaseous state; they were there combined with oxygen, and the globe at its creation was enveloped in an aeriform stratum containing some nitrogen, a great quantity of carbonic acid and little or no oxygen. Add to this the fact that at that period the earth was incandescent, and it is manifest that all the carbon which it contained would certainly have been consumed at this temperature by contact with oxygen.

Thus constituted the earth cooled down; but the composition of its atmosphere made it uninhabitable by animals, since they require oxygen which it did not

possess, and because they would have been suffocated by the carbonic acid and nitrogen which were then in the ascendency. Thus the primary strata of sedimentary rocks contain no animal remains. As a compensation, however, the earth was as favorably situated for the production of plants as it was unfavorably for the support of animals; soon it became covered with luxuriant forests, of which the accumulated remains have formed coal. In that mineral are found all the species which then existed. They were gigantic Equisetaceae, tree-ferns worthy of comparison with our oaks, and Cycadaceae surpassing in height the most magnificent objects which the vegetable kingdom has now to exhibit. While these immense deposits were being made, the oxygen, disengaged little by little by the action of the sun, enriched the atmosphere and prepared for the birth of the Animal Kingdom. Soon these early forms varying from age to age, made their appearance. At the period when coal beds were forming, the forests were populated by great reptiles, cold blooded animals requiring little oxygen; but it was not till after the almost entire disappearance of the carbonic acid that mammals which had waited for a richer atmosphere came upon the scene.

There are certain timorous ignoramuses who ask in all sincerity, what will become of the earth and of themselves, when man has burned out all the coal fields? What will become of us, good people? I am about to tell you: coal will have again become carbonic acid, oxygen will have disappeared, and monster vegetation will return: but if it is true, as certain people would have us believe, that animal species developing little by little, rise from primitive forms up to man, the return of the elements to their starting point should bring man back to his origin by an inverse degeneracy. The fact of having had crocodiles among our ancestors might be allowed; but to see in prospective a posterity composed of ichthyosaurians is the most dreadful of all metempsychoses!

To return to graver matters. If we are ignorant of the mechanism of living organs, we at least know the functions which they fulfil, and can clearly express the part which they play in the physical world. With the water and nitrogenous matter which they take from the soil, with a gas which they collect in the atmosphere, plants compose the organic matter which they accumulate in their tissues, and hold in those for the use of animals. The vegetable kingdom seems to be a great laboratory, a producing workshop (Fr. *atelier de production* in opposition to *atelier de construction, factory*), in which every plant has the same function of constituting substances as varied in their composition as the plants themselves are in form. To this common character we must add another, which is, that receiving as primary materials, carbonic acid and water (substances which have been burned) plants are able to expel the oxygen and extract the carbon and hydrogen to which they restore the power of again being burned. These chemical actions take place in their organs, which are, however, only the seat of them; the *cause* is external, it comes from the sun. Animals have a mission of a diametrically opposite character. They do not create, but destroy: in place of solidifying gases and liquids, they separate and return them to the atmosphere; finally, far from restoring bodies to a combustible state, they burn them. Herbivorous animals extract all their nourishment from plants: they transform a part of it into carbonic acid and water, and stow away the remainder in their proper organs. The carni-

vorous profit by these stores and complete the return to the atmosphere of that which plants have extracted from it, and herbivorous animals have preserved of it, and every animal, whatever may be the class to which it belongs, rejects, by natural channels, an abundant supply of nitrogenous matter, which it distributes over the soil. It is precisely this matter which plants take up again, without which they could not live, which they are able to elaborate, change, store away, and return to animals after having restored the nutritive qualities it had lost. Thus is completed this admirable circle of opposite transformation and mutual services, in which we see animal and vegetable unceasingly exchanging the same matter, the latter collecting it in a gaseous state, deoxydising and solidifying it, the former receiving it as a combustible, and giving it forth again after consumption. Priestley saw in plants predestined servants whose duty it is to purify the atmosphere; they have another function far more direct, and render a service which affects us far more closely, that of extracting and preparing our food. Their action upon the air would only be felt after a long series of ages; but if a single year of drought should annihilate the fruits of the soil, a frightful famine would, in a few months, destroy all the animals that the earth supports.

From the sun come daily food, life, strength and all our powers. Light, the chemical emanations, all the rays which that orb sends us, are extremely rapid vibrations analogous to those which produce sound: here is motion, and therefore *force*: as soon as this force strikes upon plants, it is absorbed, disappears and is destroyed. But no force is destroyed, except under the condition of having produced an effect, and of having executed some work which is an equivalent for it. Now the work which the light absorbed by leaves accomplishes is that of decomposing carbonic acid. Thus, remembering that it requires a given amount of force to disunite a given quantity of oxygen and carbon, this required force is furnished hourly and gratuitously by the sun.

If now, we place before ourselves this oxygen and carbon, and, by an inverse operation, combine them by burning the carbon, they will in reuniting produce all the force which was expended in order to separate them, that is to say, all that the sun had furnished. This will be, as experience shows, heat and light, and it will also be the force which can be collected by engines worked by fire, and employed for man's service. And, let this be well reflected upon, it is the sun which has prepared for us this heat, this light, and this force; that which it furnished to the forests of the coal measures at an epoch when man was yet uncreated, man discovers and makes use of to-day.

And, what is true of inanimate furnaces appears also, and may be repeated in these living furnaces called animals. They also consume organic matter, produce heat, raising their temperature, and develope force and motion: a force which they do not create, which they owe to this same combustion, and hold by the same right as do steam engines: a force previously poured into plants by the sun, absorbed by them, virtually preserved in their products, which constitute our food, which we set free by respiration, and which our muscles apply at will, according to our varied requirements. The whole of this great generalization of the world's phenomena is the work of chemists and modern physicists. Messrs. Dumas and Boussingault were the first to detect it; the mechanical theory of heat completed

and demonstrated it; but the whole of it already lay in the thought of Lavoisier, when he wrote: "Organisation, spontaneous motion, life, only exist on the surface of the earth, in places exposed to light. It might be said that the fable of the torch of Prometheus was the expression of a philosophical truth that had not escaped the ancients. Without light, nature was without life: she was dead and inanimate; a benevolent God, by bestowing light, has spread over the surface of the earth organization, feeling and thought."

IV.

Although, during the regular course of its existence, a plant accumulates organic matter, there are, however, two periods when it loses this essential characteristic and in which it conducts itself as do animals: these are at the commencement and at the end of its life, when it germinates and when it reproduces itself. Every seed, besides the embryo which maintains during long years the principle of life, encloses a supply of organic matter destined for the early nourishment of the growing plant. Thrown upon a warm moist soil it sprouts; its radicle seeks in the soil a point of support and liquid nourishment; the bud rises; the seminal leaves or cotyledons develope themselves, and the rudimentary plant is constituted in virtue of its intrinsic and transmitted life. But, during this primary period, the supply of matter accumulated consists of two parts; one is burned by a species of respiration; the other, undergoing complicated chemical actions, is carried into the organs and fixed there by being made a constituent part of them. Every thing takes place nearly as in an animal, and without any intervention of light: but, after this primitive phase, when the respiratory organs have gained their first development, the plant waits for the rays of the sun in order to continue its evolution, and as soon as these rays come to it, it turns towards them as if eager to collect them, becomes green and begins, to end only with death, that decomposition of carbonic acid and that accumulation of matter which is its function, and so to speak its predestination.

In order better to study this period of the intrinsic life of the seed, M. Boussingault formed the happy thought of prolonging it, by indefinitely retarding the action of light. The experiment was made upon peas in a soil destitute of manure. After having germinated they continued to grow, giving birth to a blanched, thin, and prostrate stem which perished without bearing seed. During all this time they made use of the organic matters primitively contained in the seed, and, as they dragged on their painful existence, gave these forth, little by little, in order to prolong life. Finally, each plant had lost more than half the carbon originally contained in the seed. While this experiment was going on in darkness, other peas sown at the same time were successively brought to the light. Thenceforward, everything was changed, true life was developed, and the vegetable, able at last to make use of the nourishment contained in the air, gained daily, in the sun, nearly as much carbon as it had before lost in darkness.

Everything in nature has its analogue; plants in the seed and animals in the egg appear to accomplish the same actions, and are formed in the same condition. In both cases a mass of organic matter accompanies the germ; the egg and the

seed may preserve, for a longer or shorter period, the essential principle of life. A little heat commences the evolution, and from that moment organic matter, absorbed by the infant tissues and borne thither by cells which are then formed, takes its place in the organ which it constitutes. During all this time, the plant and the animal live upon their own private store, taking nothing from without, and, to complete the analogy, consume a portion of their own substance. Soon, when all this is exhausted, the animal being formed is ready to live, as the plant assuming a shape is to vegetate, and at the same instant, a necessity common to both is apparent; that, namely, of finding nourishment from without. From this time, however, all analogy ceases, and the separation of the two kingdoms commences. The plant creates and reduces, the animal destroys and oxydizes.

Let us pursue these analogies. In every expanding flower, botany points out to us the organs of the two opposite sexes which contribute, each in its own character, to the fertilization of the ovary. Now, at the very moment when the flower seems to borrow the sexual function of reproduction which was considered to be the exclusive privilege of animals, it imitates them still more in consuming organic substances by active respiration. "All flowers," said Priestley, "constantly exhale a deadly gas during the day as well as at night, both in light and darkness." Daily experience confirms this assertion, and De Saussure has shown that this poisonous gas is carbonic acid. Finally, one of our most justly celebrated chemists, M. Cahours, has, in a recent and complete work, studied all the circumstances of this respiration of flowers and fruits.

If it be true that this combustion of organic matter, this expenditure and loss of force, are necessary to accomplish the act of fertilization in itself, it is, above all, in the sexual organs that they ought to be produced. Experience, in fact, has confirmed this view, and it has been discovered that the stamen or male organ is most active in its expenditure. This important fact does not stop there. All combustion evolves heat: it is to their respiration that animals owe their high temperature, and it is of the utmost necessity that the stamens and carpels should become heated since they breathe. The question was, to find thermometers sensible enough and a suitable plant. The first plant to permit of the height of temperature being ascertained, was the pumpkin which had never been suspected of preserving such heat. Its flowers being large, air-thermometers are easily introduced into them ; some of them are male and others female flowers, the latter of which shewed themselves much more cold than the former.

However, gourds, melons and pumpkins become warm to a very small extent, and may be said to resemble cold-blooded animals; the plants that imitate warm blooded animals are those of the Arum family. One of them, the *Arum maculatum*, found abundantly in the hedgerows, is enveloped by a folded leaf which encloses the flower within a small compass and hinders the heat from being dispersed in space. This is the singular phenomenon observed by Lamarck, Sennebier, Bory de Saint Vincent, and by Saussure himself. Habitually, the Arum is cold, but, at a given moment, which must be watched for and which the experimenter must know how to take advantage of, the plant rises from 7 to 8 degrees above the temperature of the atmosphere. Hubert, a very sagacious observer,

succeeded in introducing a small and very sensitive thermometer, first among the stamens which were heated 22 degrees, and afterwards among the carpels which produced an action only half as great. The other parts of the plant did not betray any special action. By dint of care and watchfulness, Saussure surprised four Arums at the moment of their rise in temperature, and placed them under a bell glass filled with air. Immediately, the sides of the glass became covered with mist, and a great absorption of oxygen, with a corresponding production of carbonic acid, took place. Both in its chemical action, and in the energy of that action, the plant might have been compared to a rat. Another time, Saussure dissected the plant into its different parts which he studied separately: the sexual organs consumed 132 parts of oxygen and the rest of the flower only 30.

After fertilization the fruit begins to develope itself and the plant to nourish it. Not only does the latter furnish it with the matter accumulated in its tissues, but also gives it a still greater quantity which the fruit consumes, by a species of respiration peculiar to itself. The whole of plant life thus seems to be exclusively devoted to the accomplishment of this last duty, namely, that of nourishing the fruit. By this labor, it impoverishes itself; beet and sugar-cane expend all the sugar which they contain, all plants exhaust the stores they have accumulated from the time of their youth, and when the fruit is ripe, the plant, if an annual, is reduced to a dried up skeleton, and, if perennial, remains torpid during the quiet of winter so as to recover strength and begin next year its provident function. The survey which has now been made, contains, besides the questions of detail which I desired to examine, a great truth with which I would conclude, namely, that our earth is not adequate to itself, since force is wanting to it; but it receives this from the sun, which pours the active principle upon it in the form of rays. Thanks to this gift, life is transmitted to the globe under two antagonistic forms, vegetable life, which accumulates force by creating organic matter, and animal life, which expends and dissipates what the sun furnishes and what plants absorb and preserve.

J. C.

CANADIAN INSTITUTE.

THIRTEENTH ORDINARY MEETING.

19*th March*, 1864.

In the absence of the President and Vice-Presidents, and on motion of Prof. Cherriman, Dr. Daniel Wilson was called to the Chair.

I. *The following donation to the Library was announced.*

"A popular and practical exposition of the minerals and geology of Canada, by E. J. Chapman, Ph. D." The thanks of the Institute were voted to Prof. Chapman for his donation.

II. *The following Papers were then read:*

1. By Prof. Kingston, M.A.:

"On the relative directions of different winds during rain or snow derived from the Toronto observations, in the years 1853 to 1859 inclusive."

2. By Rev. Prof. Hincks, F.L S., &c.:

"Additions to Canadian Flora."

3. By Prof. Cherriman, M.A.:

"A verbal communication on the Geometrical trisection of an angle."

The thanks of the Institute were voted to the Professors for their Papers.

FOURTEENTH ORDINARY MEETING.

2*nd April*, 1864.

The President, The Rev. J. McCaul, LL.D., in the Chair.

I. *The following donations for the Library since last meeting were announced:*

From the Halifax Institute of Science, &c.

Journal and proceedings of the House of Assembly of the Province of Nova Scotia... 1*

From the Secretary of State for India.

Magnetical and meteorological observations made at Bombay in the year 1861.

From the Society, Edinburgh.

Proceedings of the Royal Physical Society, Session 1858—1862.

From the Nova Scotia Institute.

Transactions of .... Vol. 1, Part 1

From the Historical Society, Chicago.

Transactions of the Illinois State Agricultural Society, Vols. 3, 4, and abstract of a report on Illinois coals, by the state geologist.

From E. Allen, Esq., London.

Catalogue of old and rare works.

II. *The following Paper was read:*

By the Rev. Dr. Scadding;

"On Errata Recepta, written and spoken." A lengthened conversation followed at the conclusion of which the thanks of the Institute were on motion of Dr. Campbell, voted to Dr. Scadding.

FIFTEENTH ORDINARY MEETING.

9th April, 1864.

The Vice-President S. FLEMING, Esq., C.E., in the Chair.

I. *The following Gentlemen who were duly proposed at the last meeting as members of the Institute were balloted for, and declared unanimously elected,—viz.*

JOHN L. BLAIKIE, ESQ., Toronto.
WILLIAM ALEXANDER, ESQ., Toronto.
B. MCMURRICH, ESQ., B.A., Toronto.

II. *The following donations for the Library and Museum received since last meeting were announced.*

FROM THE REGENTS OF THE UNIVERSITY OF NEW YORK STATE.

Appendix.. 1

For which the thanks of the Institute were voted.

FOR THE MUSEUM FROM S. FLEMING, ESQ., C.E.

"Specimen of Gypsum obtained by him on the banks of the Tobique River, New Brunswick."

The thanks of the Institute were voted to Mr. Fleming.

III- *The following Paper was then read:*

By W. Ogden, Esq., M.D.:

"On Quackery, and a novel remedy for the treatment of certain chronic diseases."

A conversation on the subject followed in which Dr. Tucker, Prof. Croft and Dr. Wright took part. The thanks of the Institute were voted to Doctor Ogden.

SIXTEENTH ORDINARY MEETING.

16th April, 1864.

The President, The REV. J. MCCAUL, LL.D., in the Chair.

I. J. T. Gilbert, Esq., was proposed a member of the Canadian Institute by J. McCaul and Daniel Wilson; it being the last meeting of the session, on motion of Doctor Wilson a ballot took place and Mr. Gilbert was declared elected.

II. Doctor Roseburgh presented to the Institute an opthalmoscope.

III.—1. A paper was read by Doctor Tucker:

"On Secluded tribes of Uncivilized Men."

2. Doctor Barrett read Dr. Rosebrugh's Paper:

"On the opthalmoscope as modified lately introduced by him."

3. Doctor Wilson Read a Paper:

"Canadian Type of the French Skull."

This being the last meeting of the Session, and in accordance with the Rules and Regulations of the Institute the auditors were appointed for the year.

The President Nominated Mr. G. H. Wilson, and on motion of Doctor Wilson seconded by Mr. Wood, Mr. S. Spreull was elected.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—AUGUST, 1864.

Latitude—43 *deg.* 39.4 *min. North. Longitude*—5 *h.* 17 *m.* 33 *s. West. Elevation above Lake Ontario,* 108 *feet.*

Day.	Barom. at temp. of 32°. 6 A.M.	2 P.M.	10 P.M.	Mean.	Temp. of the Air. 6 A.M.	2 P.M.	10 P.M.	ME'N	Excess of mean above Normal.	Tens. of Vapour. 6 A.M.	2 P.M.	10 P.M.	M'N	Humidity of Air. 6 A.M.	2 P.M.	10 P.M.	M'N	Direction of Wind. 6 A.M.	2 P.M.	10 P.M.	Resul't. Direction.	Velocity of Wind. 6 A.M.	2 P.M.	10 P.M.	Resul't.	ME'N	Rain in inches.	Snow in inches.
					°	°	°	°	°												°							
1	29.435	29.382	29.416	29.4088	71.7	80.0	74.6	75.95	+ 8.98	.646	.662	.733	.674	.84	.64	.86	.76	s w b s	s w b s	N b w	s 42 w	0.5	12.4	1.4	5.24	6.32	0.930	...
2	.446	.488	.533	.4912	68.8	74.2	67.0	70.07	+ 3.22	.627	.598	.553	.571	.89	.71	.83	.78	N b w	E S E	E b N	N 41 E	7.2	3.4	4.5	3.68	5.57	Inp.	...
3	.516	.497	.462	.4920	65.6	71.0	64.1	66.35	— 0.50	.429	.460	.499	.459	.67	.60	.83	.71	N	E b s	N W b N	N 14 E	12.0	7.0	1.0	4.86	5.85	Inp.	...
4	.434	.412	.457	.4347	62.7	73.8	65.6	68.02	+ 1.22	.478	.516	.531	.517	.84	.65	.84	.76	N b w	s s w	s s w	s 35 w	6.5	6.2	0.8	1.03	2.55	...	...
5	.523	.598	.652	.5967	62.7	77.5	67.0	70.37	+ 3.57	.454	.568	.553	.550	.79	.60	.83	.74	N W b w	s E b s	Calm.	s 53 E	0.2	4.0	0.0	0.87	1.08	...	...
6	.693	.706	.713	.7030	65.2	79.6	69.9	71.38	+ 4.62	.510	.590	.570	.543	.81	.58	.77	.71	Calm.	s s E	s s E	s 18 E	0.0	7.0	0.5	1.43	2.35	...	...
7	.749	.739	—	—	62.3	80.3	—	—	—	.484	.560	—	—	.86	.54	—	—	N N W	s s w	s w b w	s 87 w	2.2	10.0	3.5	2.75	3.95	...	...
8	.737	.611	.599	.6455	66.6	92.6	75.3	78.77	+12.10	.518	.589	.569	.563	.79	.39	.65	.60	N W	N W	N W	N 68 W	2.2	10.2	3.0	4.99	6.18	...	...
9	.595	.474	.448	.4997	68.1	84.3	75.3	77.33	+10.78	.524	.653	.513	.537	.77	.54	.58	.58	W N W	s s w	s w	s 58 w	0.8	7.8	2.2	4.92	5.46	...	...
10	.457	.409	.433	.4315	72.5	89.4	77.1	80.18	+13.67	.607	.788	.650	.685	.76	.57	.70	.66	W	s w	W s w	s 55 w	6.0	7.0	2.5	3.32	3.85	...	...
11	.467	.472	.539	.4942	73.8	85.0	71.7	76.60	+10.17	.682	.692	.588	.634	.82	.57	.76	.70	Calm.	Calm.	N N E	N 39 E	0.0	0.0	4.5	1.95	2.38	0.210	...
12	.588	.533	.508	.5313	68.4	73.5	73.1	72.77	+ 6.43	.548	.667	.582	.614	.79	.81	.72	.76	W N W	s w b s	s s w	s 73 w	3.0	3.5	4.4	2.19	3.11	0.320	...
13	.454	.395	.512	.4550	73.5	73.5	68.8	71.98	+ 5.75	.716	.716	.612	.676	.87	.87	.88	.85	s w b s	w b s	N W	s 77 w	5.2	10.8	3.8	4.65	5.68	0.905	...
14	.610	.624	—	—	63.7	81.8	—	—	—	.491	.637	—	—	.83	.58	—	—	N W b N	N N W	W s w	N 51 W	3.0	13.0	2.0	3.64	4.19	...	...
15	.685	.635	.623	.6428	61.9	77.8	68.4	70.28	+ 4.13	.436	.519	.533	.495	.79	.55	.77	.68	N N W	s E b s	E b s	s 89 E	0.8	3.0	1.5	2.83	3.91	...	...
16	.619	.588	.602	.6015	65.9	79.3	70.6	71.93	+ 5.90	.527	.688	.561	.594	.83	.68	.75	.76	Calm.	Calm.	Calm.	N 28 W	0.0	0.0	0.0	1.35	1.19	...	...
17	.576	.604	.645	.6100	69.1	77.8	65.6	70.40	+ 4.43	.580	.408	.340	.442	.81	.42	.53	.60	N W b N	N	N N W	N 7 W	3.2	8.0	9.8	8.41	8.78	Inp.	...
18	.691	.726	.793	.7417	59.4	70.2	58.3	63.43	— 2.40	.434	.404	.367	.400	.86	.54	.75	.69	N N E	s E b s	Calm.	N 47 E	6.0	3.8	0.0	0.98	2.15	...	...
19	.831	.817	.791	.8145	59.4	69.9	64.8	64.52	— 1.25	.275	.487	.450	.416	.54	.67	.73	.67	N b w	s s E	s E b s	N 50 E	5.2	2.5	3.0	1.44	2.70	0.005	...
20	.795	.769	.675	.7413	65.2	60.1	61.6	62.42	— 3.13	.577	.463	.428	.471	.92	.89	.78	.83	N E b E	E b N	N E b E	N 88 E	1.2	14.5	12.0	9.51	10.29	0.905	...
21	.590	.564	—	—	65.2	67.0	—	—	—	.619	.608	—	—	.99	.92	—	—	s E b E	E b N	s b E	s 83 E	3.2	5.6	1.5	2.90	3.42	0.300	...
22	.556	.531	.565	.5505	66.6	67.7	63.4	65.87	+ 0.52	.614	.557	.494	.538	.93	.82	.85	.84	Calm.	N	N W b N	N 39 W	0.0	0.2	11.5	3.89	4.02	Inp.	...
23	.656	.645	.633	.6377	65.5	71.0	63.4	64.25	— 0.88	.404	.541	.533	.500	.92	.71	.91	.83	N W b W	s s w	Calm.	s 57 w	0.8	6.5	0.0	1.69	2.16	...	...
24	.599	.488	.463	.5090	65.9	76.7	68.8	70.83	+ 5.88	.567	.656	.569	.605	.89	.71	.81	.81	s b w	s s E	Calm.	s 11 w	1.0	4.0	0.0	2.18	2.27	...	...
25	.410	.260	.405	.3528	65.2	76.7	66.3	69.27	+ 4.53	.577	.739	.394	.582	.92	.80	.61	.78	Calm.	s s w	N W b W	s 40 w	0.0	12.8	2.0	4.76	5.75	0.030	...
26	.466	.311	.164	.2892	55.8	69.9	62.3	63.27	— 1.27	.355	.501	.522	.479	.80	.68	.93	.82	Calm.	s s w	s s E	s 53 E	0.0	1.2	9.0	2.43	5.10	1.325	...
27	.120	.115	.216	.1493	59.0	68.8	67.3	61.58	— 2.77	.462	.451	.381	.425	.93	.64	.80	.79	w b s	w s w	w b N	s 83 W	2.2	14.5	9.0	9.46	9.72	0.010	...
28	.242	.286	—	—	57.6	67.0	—	—	—	.399	.423	—	—	.84	.63	—	—	w s w	w b N	w	N 82 W	6.2	13.0	8.0	7.07	7.32	0.105	...
29	.408	.428	.520	.4577	55.1	64.5	56.2	59.73	— 4.08	.377	.404	.360	.391	.87	.66	.80	.76	w b s	N W	Calm.	N 70 W	1.8	12.8	0.0	8.05	8.28	...	...
30	.593	.625	.704	.6470	54.0	64.5	52.9	57.02	— 6.60	.335	.251	.216	.264	.80	.41	.52	.57	N W	N N W	N W b N	N 27 W	7.0	10.8	7.5	7.35	7.67	0.015	...
31	.780	.791	.787	.7877	48.6	63.4	58.7	57.18	— 6.13	.241	.356	.304	.303	.69	.61	.62	.66	N	s w b s	N b w	s 78 w	2.5	9.5	4.0	1.14	3.75	...	...
M	29.5604	29.5300	29.5503	29.5450	63.93	74.54	66.23	68.58	+ 2.82	.500	.554	.496	.516	.82	.64	.76	.73	....	....	....	....	2.90	7.26	3.64	......	4.75	5.060	0.0

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR AUGUST, 1864.

Note.—The monthly means do not include Sunday observations. The daily means, excepting those that relate to the wind, are derived from six observations daily, namely, at 6 A.M., 8 A.M., 2 P.M., 4 P.M., 10 P.M., and midnight. The means and resultants for the wind are from hourly observations.

Highest Barometer . . . . 29.863 at 8 a.m. on 19th. } Monthly range=
Lowest Barometer . . . . 29.099 at 10.20 a.m. on 27th. } 0.764 inches.

Self-registering Ther.:
- Maximum temperature . . . , 94°0 on p.m. of 8th } Monthly range=
- Minimum temperature . . . . 47°0 on a.m. of 31st } 47°0
- Mean maximum temperature . . 77°24 } Mean daily range=15°83
- Mean minimum temperature . . 61°41 }
- Greatest daily range . . . . . . 29°2 from a. m. to p. m. of 8th.
- Least daily range . . . . 3°8 from a. m. to p. m. of 22nd.

Warmest day . . . 10th ..Mean Temperature . . . 80°18 } Difference=23°.16
Coldest day . . . . 30th...Mean Temperature . . . 57°02 }
Maximum Radiation { Solar (Vacuum) . . . . . . 127°0 on p. m of 1st } Monthly range=
{ Terrestrial . . . . 74°0 on a. m. of 20th } 53°.0
Aurora observed on 6 nights, viz.:—on 13th, 24th, 25th, 28th, 30th and 31st.
Possible to see Aurora on 12 nights; impossible on 19 nights.
Raining on 16 days; depth 5.060 inches; duration of fall, 57.8 hours.
Mean of cloudiness=0.70; above average, 0.23. Most cloudy hour observed, 4 p.m; mean=0.73; least cloudy hour observed, 10 p.m; mean=0.63.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
1262.51	903.32	661.61	1626.71

Resultant direction, N. 70° W.; Resultant Velocity, 1.38 miles per hour.
Mean velocity 4.75 miles per hour.
Maximum velocity 20.2 miles, from 4 to 5 p.m. on 27th.
Most windy day 20th—Mean velocity 10.29 miles per hour. } Difference 9.21.
Least windy day 5th—Mean velocity 1.08 miles per hour. }
Most windy hour, noon to 1 p.m.—Mean velocity, 8.02 miles per hour. } Difference
Least windy hour, 3 to 4 a.m.—Mean velocity, 2.87 miles per hour. } 5.15 miles.

1st. Thunder and slight rain, 1 to 2 p.m.; sheet lightning and constant rain from 9 p.m.—6th. Distant thunder in W. 4 to 5 p.m.—8th to 13th, inclusive, very sultry days—10th. Sheet lightning in S.W at midnight.—11th. Thunder, lightning, and rain nearly all day.—12th. Thunderstorm, lightning, and rain, 10.50 to 11 30 a.m.—13th. Thunderstorm 3 to 5.30 a.m., and again from 10.30 a.m. to 4 p.m.; auroral arch, patches and streamers at midnight.—21st. Thunder in S.W. 11 30 a.m. to 2 p.m.—24th. Loud thunder and vivid lightning, 5 to 6 p m.; 9.50 to 10 30 p.m., a beautiful and well defined auroral band, extending from horizon in W.N.W. to E.S.E., being about 2° in breadth, and passing the meridian considerably to S. of Zenith.—25th. Fog at 6 a.m.; thunderstorm 11.30 a.m. to 12.30 p.m.; faint aurora in N. from 8 p.m. to midnight.—26th. Thunderstorm, lightning, and rain, 3 p.m. to midnight—28th, 30th, and 31st.—Faint auroral light in N. at midnight.

Heavy Dew recorded on 9 mornings during this month.

COMPARATIVE TABLE FOR AUGUST.

YEAR.	TEMPERATURE. Mean.	Excess above Average (45°5).	Maximum observed.	Minimum observed.	Range.	RAIN. No. of days.	Inches.	SNOW. No. of days.	Inches.	WIND. Resultant. Direction.	Velocity.	Mean Force or Velocity
1840	64.7	— 1.5	80.1	47.4	32.7	12	2.905	...	...	...	...	...
1841	64.4	— 1.8	83.5	46.7	36.8	9	6.170	...	...	...	...	0.19 lbs
1842	65.7	— 0.5	80.7	45.3	35.4	6	2.500	...	...	...	...	0.30 "
1843	66.4	+ 0.2	85.5	44.4	41.1	4	4.850	...	...	...	...	0.12 "
1844	64.3	— 1.9	82.5	44.3	38.2	17	Imp	...	...	...	...	0.16 "
1845	67.9	+ 1.7	82.5	44.4	38.1	9	1.723	...	...	...	...	0.19 "
1846	68.4	+ 2.2	86.3	50.4	35.9	9	1.770	...	...	...	...	0.17 "
1847	65.1	— 1.1	83.1	44.9	38.2	10	2.140	...	...	...	...	0.19 "
1848	69.2	+ 3.0	87.5	49.3	38.2	8	0.857	...	...	S 21 E	0.98	4.55 ms
1849	66.3	+ 0.1	79.5	51.4	28.1	10	4.970	...	...	N 71 W	0.60	3.76 "
1850	66.8	+ 0.6	84.2	43.0	41.2	13	4.355	...	...	N 15 E	0.35	4.46 "
1851	63.6	— 2.6	79.8	43.6	36.2	10	1.360	...	...	N 63 W	0.40	4.63 "
1852	65.9	— 0.3	81.2	46.7	34.5	9	2.695	...	...	N 70 E	0.56	3.30 "
1853	68.6	+ 2.4	91.6	47.6	44.0	11	2.575	...	...	S 36 E	0.30	4.26 "
1854	68.0	+ 1.8	98.1	47.0	51.1	5	0.455	...	...	N 64 W	1.76	4.60 "
1855	64.1	— 2.1	82.1	44.9	37.2	7	1.455	...	...	N 63 W	1.04	6.97 "
1856	63.6	— 2.6	81.3	44.0	37.3	12	1.680	...	...	N 50 W	2.88	7.03 "
1857	65.3	— 0.9	85.3	50.1	35.2	13	5.265	...	...	N 77 W	1.51	6.36 "
1858	67.6	+ 1.4	83.4	45.4	38.0	11	3.890	...	...	N 69 W	1.57	6.50 "
1859	66.6	+ 0.4	81.4	46.2	35.2	11	3.900	...	...	N 36 W	1.62	5.96 "
1860	64.5	— 1.7	81.8	47.1	34.7	14	3.405	...	...	N 70 W	1.83	5.80 "
1861	65.5	— 0.7	82.5	48.2	34.3	15	2.953	...	...	N 8 E	0.46	4.21 "
1862	67.6	+ 1.4	87.6	47.7	39.9	15	3.483	...	...	N 78 W	1.67	5.96 "
1863	66.6	+ 0.4	87.2	43.9	43.3	12	2.208	...	...	S 61 W	1.80	4.89 "
1864	68.6	+ 2.4	92.6	48.6	44.0	16	5.060	...	...	N 70 W	1.38	4.75 "
Results to 1864.	66.21	...	84.45	46.50	37.95	10.7	3.026	...	...	N 67 W	0.93	5.18
Exc. for 1864.	+2.37	...	+8.15	+2.10	+6.05	+ 5.3	+ 2.034	...	...	...	...	—0.43

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Day.	Barom. at temp. of 32°. 6 A.M.	2 P.M.	10 P.M.	MEAN.	Temp. of the Air. 6 A.M.	2 P.M.	10 PM	ME'N	Excess of mean above Normal.	Tens. of Vapour. 6 A.M.	2 P.M.	10 P.M.	M'N	Humidity of Air. 6 A.M.	2 P.M.	10 P.M.	M'N
1	29.823	29.776	29.741	29.7727	° 47.2	° 67.0	° 59.8	° 59.50	° — 3.53	.279	.416	.334	.362	.86	.63	.65	.71
2	.691	.639	.610	.6407	57.2	65.2	60.5	61.63	— 1.10	.358	.421	.458	.425	.76	.67	.87	.77
3	.558	.508	.500	.5188	59.4	67.0	56.9	61.75	— 0.35	.434	.460	.374	.416	.86	.70	.80	.76
4	.496	.508	—	—	54.7	68.8	—	—	—	.403	.557	—	—	.94	.79	—	—
5	.665	.688	.747	.7023	55.8	58.7	59.0	57.90	— 3.93	.422	.373	.335	.366	.95	.75	.67	.76
6	.820	.862	.895	.8683	55.8	63.7	54.4	58.27	— 3.17	.365	.352	.303	.336	.82	.60	.73	.69
7	.966	.949	.876	.9260	51.5	64.8	61.2	59.93	— 1.22	.283	.361	.374	.354	.74	.59	.69	.68
8	.827	.779	.735	.7725	57.6	59.2	59.4	58.47	— 2.27	.364	.413	.464	.426	.76	.82	.92	.87
9	.677	.534	.507	.5647	60.5	72.4	62.3	65.37	+ 5.02	.470	.550	.484	.519	.89	.69	.86	.83
10	.534	.514	.483	.5072	52.9	65.9	60.1	60.50	+ 0.45	.381	.461	.425	.434	.95	.72	.81	.82
11	.518	.534	—	—	55.8	62.7	—	—	—	.338	.287	—	—	.87	.50	—	—
12	.653	.675	.711	.6795	47.5	61.6	56.5	55.62	— 3.62	.294	.289	.281	.277	.89	.53	.61	.64
13	.685	.550	.547	.5872	47.9	67.7	54.7	57.13	— 1.72	.278	.243	.251	.251	.84	.35	.58	.56
14	.432	.238	.306	.3133	49.7	57.2	55.1	55.20	— 3.13	.287	.439	.386	.394	.80	.94	.89	.90
15	.255	.374	.499	.3817	54.7	59.8	49.3	55.63	— 2.28	.380	.292	.293	.332	.89	.56	.83	.75
16	.540	.586	.652	.5950	47.5	61.6	49.3	52.73	— 4.78	.283	.257	.274	.262	.86	.46	.77	.67
17	.688	.605	.501	.5893	41.0	60.5	54.4	53.40	— 3.60	.218	.303	.385	.310	.85	.58	.91	.76
18	.412	.283	—	—	56.5	69.9	—	—	—	.323	.461	—	—	.71	.63	—	—
19	.536	.598	.658	.6063	45.0	56.2	49.7	51.13	— 4.98	.249	.264	.267	.264	.83	.58	.75	.71
20	.643	.602	.689	.6468	42.8	68.1	53.6	55.45	— 0.15	.250	.261	.246	.259	.90	.38	.59	.62
21	.693	.636	.711	.6815	47.9	60.9	54.0	55.28	+ 0.17	.301	.343	.357	.325	.90	.64	.85	.75
22	.700	.603	.517	.5925	47.2	55.1	55.1	52.22	— 2.42	.229	.358	.409	.334	.71	.83	.95	.84
23	.458	.386	.306	.3770	54.4	67.7	63.7	63.25	+ 9.03	.418	.557	.491	.510	.99	.82	.83	.87
24	.230	.276	.399	.3142	60.1	64.8	50.8	57.23	+ 3.48	.489	.351	.233	.329	.94	.56	.63	.68
25	.587	.645	—	—	43.5	54.0	—	—	—	.214	.282	—	—	.75	.67	—	—
26	.722	.620	.493	.5982	45.4	53.3	50.8	49.70	— 3.03	.263	.312	.313	.295	.86	.76	.84	.82
27	.491	.357	.436	.4272	55.1	66.3	58.7	60.38	+ 8.17	.386	.419	.442	.416	.89	.64	.90	.80
28	.664	.797	.857	.7850	49.7	59.1	47.2	52.03	+ 0.20	.349	.322	.219	.287	.98	.65	.67	.74
29	.715	.353	.612	.5555	47.5	57.6	46.8	50.93	— 0.38	.294	.446	.273	.331	.89	.94	.85	.86
30	.786	.839	.909	.8500	41.4	46.8	45.3	44.62	— 6.20	.214	.206	.217	.214	.81	.64	.71	.73
...	...	...	...	...	...	...	...	..	...	...	...	...	...	...	...	...	...
M	29.6328	29.5902	29.6114	29.6097	50.87	61.85	54.95	56.36	— 1.13	.328	.364	.342	.347	86	.65	.78	.75

Day.	Direction of Wind. 6 A.M.	2 P.M.	10 P.M.	Resultant Direction.	Velocity of Wind. 6 A.M.	2 P.M.	10 PM	Resul't.	ME'N	Rain in Inches.	Snow in Inches.
1	N b W	S W b S	Calm.	S 47° W	1.8	3.5	0.0	1.02	1.55	...	...
2	S W b S	E	E	N 65 E	3.5	6.0	2.2	1.95	2.86	Inp.	...
3	N N E	E b S	Calm.	N 72 E	1.5	5.0	0.0	2.57	3.82	...	...
4	N	E S E	E N E	N 62 E	1.5	6.0	7.5	4.94	5.46	0.005	...
5	N E	E	N E b E	N 59 E	7.5	11.2	10.2	9.43	9.65	..	...
6	N E	E b S	E	N 72 E	8.8	11.5	5.2	6.87	7.62	...	...
7	N N E	E	E S E	S 80 E	3.4	12.8	9.8	7.95	8.59	0.040	...
8	S E	S S E	S S W	S 7 E	5.8	5.8	1.5	3.12	3.58	0.005	...
9	S W b S	S W b S	N W	S 70 W	7.6	14.0	1.5	3.36	4.94	...	...
10	N W	S S E	S b E	N 88 E	0.5	4.6	2.2	0.97	3.76	0.025	...
11	N N E	NW bN	N N W	N 23 W	0.5	12.8	7.8	8.95	9.36	...	...
12	N b W	N b E	N b W	N 3 W	12.5	11.4	5.5	7.59	8.70	...	...
13	N b W	NW bN	N b W	N 24 W	5.5	9.0	12.0	7.42	7.66	...	...
14	W b W	S	S b W	S 47 W	2.9	9.4	4.5	5.27	7.03	0.290	...
15	W S W	W N W	W	N 76 W	11.2	22.0	4.2	13.49	13.88	...	...
16	W	N N W	N N W	N 40 W	3.5	11.0	1.2	5.14	5.41	...	...
17	Calm.	S S E	E	S 69 E	0.0	3.0	2.0	2.04	2.94	...	...
18	E	S b W	NWbW	S 51 W	3.0	14.0	11.5	5.63	8.03	0.835	...
19	W S W	W b N	Calm.	N 81 W	4.0	12.0	0.0	4.55	4.67	...	...
20	W S W	W b S	W	S 82 W	0.6	16.8	4.0	6.64	6.85	...	...
21	W b N	N	N N E	N 45 E	2.8	12.8	4.2	4.52	6.40	...	...
22	N E b E	E N E	E N E	N 66 E	11.5	6.8	5.0	6.65	6.69	...	...
23	E	S S W	S W b S	S 30 W	2.2	10.2	4.5	5.97	6.86	0.078	...
24	S W	W N W	W N W	N 80 W	8.0	17.8	20.0	13.90	14.55	...	...
25	W N W	W N W	W b N	N 63 W	9.5	18.5	0.5	9.44	9.51	...	...
26	W b N	E b N	N E	N 75 E	1.0	10.0	2.3	4.17	5.65	Inp.	...
27	S W b S	S W b S	S W	S 58 W	7.6	20.5	2.5	9.26	12.72	0.080	...
28	N W	S W b W	N	N 38 W	9.5	7.0	6.0	3.63	6.77	...	...
29	N E b E	S S E	N W	N 20 W	9.8	2.0	14.2	6.20	11.06	1.150	...
30	NW bN	N b E	N E b N	N 14 E	4.8	7.8	1.5	4.85	5.20	...	...
...	...	...	...	...	...	...	...	...	...	...	...
M	....	....	....	....	5.08	10.51	5.11	......	7.06	2.508	...

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR SEPTEMBER, 1864.

Note.—The monthly means do not include Sunday observations. The daily means, excepting those that relate to the wind, are derived from six observations daily, namely at 6 A.M., 8 A.M., 2 P.M., 4 P.M., 10 P.M., and midnight. The means and resultants for the wind are from hourly observations.

Highest Barometer..............................29.975 at 8 a.m. on 7th } Monthly range =
Lowest Barometer..............................29.230 at 6 a.m. on 24th } 0.745 inches.

Self-regist'ing Thermom.
- Maximum Temperature ....73°0 on p.m. of 9th } Monthly range =
- Minimum Temperature ....37°8 on a.m. of 17th } 35°2
- Mean maximum Temperature .... 63°94 } Mean daily range=
- Mean minimum Temperature .... 48°96 } 14°98
- Greatest daily range ......27°0 from a.m. to p.m. of 20th.
- Least daily range............ 4°5 from a.m. to p.m. of 8th.

Warmest day .... 9th... Mean temperature.......... 65°37 } Difference = 20°75.
Coldest day .... 30th... Mean temperature .... 44°62 }
Maximum Radiation. { Solar.................................. 115°0 on p.m. of 9th } Monthly range =
{ Terrestrial........................... 29°8 on a.m. of 17th } 85°2
Aurora observed on 4 nights, viz.,—on 20th, 21st, 22nd and 24th.
Possible to see Aurora on 14 nights; impossible on 16 nights.
Raining on 11 days, depth 2.508 inches; duration of fall 31.0 hours.
Mean of cloudiness = 0.58; above average .08.
Most cloudy hour observed, 2 p.m.; mean = 0.67; least cloudy hour observed, 6 a.m.; mean, = 0.50.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
1970.72	902.38	1364.93	2205.17

Resultant direction N. 38° W.; Resultant velocity 1.89 miles per hour.
Mean velocity ....7.06 miles per hour.
Maximum velocity .... 27.4 miles, from 2 to 3 p.m. on 15th.
Most windy day ......24th............Mean velocity, 14.55 miles per hour. } Difference=
Least windy day......1st............Mean velocity, 1.55 ditto } 13.00 miles.
Most windy hour ...... 2 to 3 p.m.........Mean velocity, 10.94 ditto. } Difference=
Least windy hour ...... 8 to 9 p.m.........Mean velocity, 4.77 ditto. } 6.17 miles.

7th. Imperfect solar halo at 4 p.m.—9th. Sheet lightning in N.W. at 10 p.m. and midnight.—10th. Fog at 6 a.m.; solar halo at 2 p.m.—17th. Hoar Frost 5.30 to 6.30 a.m. (first of the season.)—18th. Thunderstorm 3 to 6 p.m.; imperfect rainbow at 6 p.m.—20th. Auroral arch and streamers, 6.45 p.m. to midnight.—21st. Auroral light and faint streamers at 10 p.m.—22nd. Auroral light and streamers, 10 p.m. and midnight; fog at midnight.—23rd. Ground fog, 6 a.m.; sheet lightning and distant thunder from 10 p.m.—24th. Thunderstorm 12.30 to 2 a.m.; faint auroral light at 9 p.m.—26th. Thunderstorm, vivid lightning and slight rain, 7 p.m. to midnight.—29th. Thunderstorm 8.30 to 11 a.m.

Heavy dew recorded on 10 mornings during this month.

COMPARATIVE TABLE FOR SEPTEMBER.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above aver'ge (26.1)	Max. observed.	Min. observed.	Range.	No. of days.	Inches	No. of days.	Inches	Resultant. Direction.	Resultant. V'y.	Mean Force or Velocity.
1840	54.0°	—3.8°	70.2°	29.4°	40.8°	4	1.380	...	...	...	...	....
1841	61.3	+ 3.5	79.9	37.5	42.4	9	3.340	...	...	...	...	0.26 lbs.
1842	55.7	— 2.1	83.5	28.3	55.2	12	6.160	..	...	...	...	0.45
1843	59.1	+ 1.3	87.8	33.1	54.7	10	9.760	...	...	...	...	0.57
1844	58.6	+ 0.8	81.5	29.6	51.9	4	Imp.	...	...	...	...	0.26
1845	56.0	— 1.8	78.8	35.3	43.5	16	6.245	...	...	...	...	0.54
1846	63.6	+ 5.8	84.0	39.0	45.0	11	4.593	...	...	...	...	0.33
1847	55.6	— 2.2	74.8	38.1	36.7	15	6.665	...	...	...	...	0.33
1848	54.2	— 3.6	80.9	29.5	51.4	11	3.115	...	...	N 71° W	2.38	5.81 mls.
1849	58.2	+ 0.4	80.6	33.5	47.1	9	1.486	...	...	N 75° W	0.69	4.23
1850	56.5	— 1.3	76.0	31.7	44.3	11	1.735	...	...	S 65° W	1.02	4.78
1851	60.0	+ 2.2	86.3	33.4	52.9	9	2.665	...	...	N 14° E	1.03	5.45
1852	57.5	— 0.3	81.8	36.1	45.7	10	3.630	...	...	N 77° W	0.53	4.60
1853	58.8	+ 1.0	85.4	36.1	49.3	12	5.140	...	...	N	1.06	4.33
1854	61.0	+ 3.2	93.1	36.3	56.8	14	5.373	...	...	N 22° W	1.33	4.04
1855	59.5	+ 1.7	81.7	36.1	45.6	12	5.585	...	...	N 20° E	1.29	7.61
1856	57.1	— 0.7	77.3	37.4	39.9	13	4.105	...	...	S 79° W	1.98	6.53
1857	58.6	+ 0.8	81.4	34.1	47.3	11	2.640	...	...	N 68° W	1.61	5.55
1858	59.1	+ 1.3	80.1	36.8	43.3	8	0.735	...	...	S 74° W	1.53	5.69
1859	55.2	— 2.6	73.8	35.7	38.1	15	3.528	...	...	N 44° W	1.60	6.36
1860	55.3	— 2.5	74.2	28.7	45.5	14	1.959	...	...	N 71° W	2.63	5.79
1861	59.1	+ 1.3	78.2	37.1	41.1	17	3.607	...	...	N 71° W	1.39	4.81
1862	59.6	+ 1.8	78.9	41.0	37.9	9	2.344	...	...	N 59° W	1.07	5.11
1863	55.9	— 1.9	78.2	31.6	46.6	8	1.235	...	...	N 16° W	0.92	6.46
1864	56.4	— 1.4	72.4	41.0	31.4	11	2.508	...	...	N 38° W	1.89	7.06
Results to 1864.	57.84	...	80.03	34.66	45.38	11.0	3.730	...	...	N 57° W	1.15	5.54
Exc. for 1864.	— 1.48	...	— 7.63	+ 6.34	— 13.98	0.0	— 1.222	...	...	....	... ..	+ 1.52

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